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FIRST AID
TO THE DISABLED
LOCOMOTIVE ENGINE

1907

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FIRST AID

— TO THE —

DISABLED LOCOMOTIVE

ENGINE, AIR BRAKE AND AIR SIGNAL INCLUDING THE WALCHART VALVE GEAR, INSIDE ADMISSION PISTON VALVES, DIRECT AND INDIRECT VALVE MOTION AND THE LATEST AIR BRAKE EQUIPMENT.

A CATECHISM

CONCERNING BREAKS AND FAILURES THAT ARE LIABLE TO OCCUR. HOW TO PREVENT SOME AND TO LOCATE AND REPAIR OTHERS.

— BY —

JOHN M. BURLEY

Compiled from Sixteen Years Actual Experience as Locomotive Engineer.

1907

PRICE, $1.50

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By JOHN M. BURLEY
State Line, Pa.

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PREFACE.

The object of this work is to give some informatien from practical experience concering the breaks, failures and defects of the air brake and air signal systems and all types of locomotive engines, injectors, metalic packing, lubricators and lubricatiyn, that will assist the locomotive engineer, fireman and trainman to prevent some of them, and in locatiug and making temporary repairs to others. Shopmen will find this a handy book. There has been considerable new matter incorporated in this enlarged edition. For the car air brakemen the K 2 tripple valve, the defects of the auxiliary reservoir and its connections and adjusting piston travel. For all concerned in a work of this kind, the Walchaert valve gear, inside admission piston valve, direct and indirect valve motion, the cross compound air pump, combined automatic straight air, the E. T. locomotive equipment, the use of hard grease as a lubricant, the parts contained in this book that all railroad men are familiar the breaks, failures and defects are treated only, the new parts there is a short explanation concerning the operation of each part, The writers aim has been to be brief and to the point. In all cases when dealing with a breakdown, failure or defect always use your reason first and your hands afterwards. Bear in mind that good judgment is the first requisite for a successful railroad man in any capacity.

Hoping that by my efforts that I have been able to put before the railroad men a convenient reference book.

J. M. BURLEY,

State Line, Pa., January 1907.

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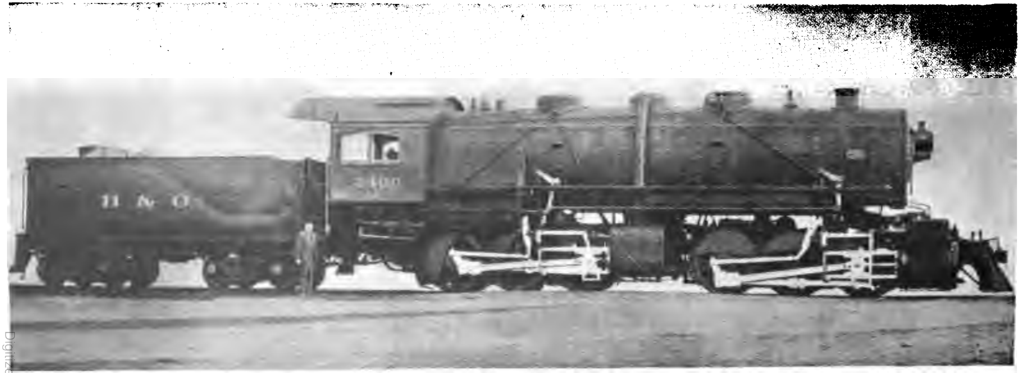
FIRST AID TO THE
DISABLED LOCOMOTIVE ENGINE,
AIR BRAKE AND AIR SIGNAL

FOUR-CYLINDER ARTICULATED COMPOUND LOCOMOTIVE.

Built by the American Locomotive Co. for the B. & O. R. R.

This type of engine permits compounding under the most advantageous conditions, as the high-pressure cylinders can be applied to one truck and the low-pressure cylinders to the other, and any desired cylinder ratios can be adopted. This divides the work equally between the two sides of the engine, and the retardation of cut-off peculiar to the compound system gives a more nearly uniform turning moment. In the engine of this type, each pair of cylinders is connected with three pairs of driving wheels, the rear high-pressure group being rigidly attached to the boiler, while the forward or low-pressure group is on a swiveling frame, the motion of which about its center is duly restrained by springs which also tend to bring the forward group of wheels into proper alignment when the engine enters a tangent. The wheel base of each group of 3 pairs of driving wheels is 10 feet, and total wheel base of the engine is 30 feet, 8 inches. The total weight of the engine, in working order, is 334,500 pounds, or slightly over 10,900 pounds per running foot of wheel base. The



FOUR CYLINDER ARTICULATED COMPOUND LOCOMOTIVE.

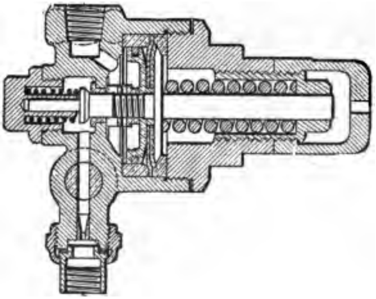
normal tractive power, when running compound, is about 70,000 pounds, but this can be increased (by working the engine simple) to 85,000 pounds.

Steam pipes from the dome are led down the outside of the boiler to the high-pressure steam chests. The high-pressure exhaust is led to a receiver located between the high-pressure cylinders, and thence by a pipe (fitted with swivel and expansion joints) to the cylinder saddle of the forward or low-pressure engine, the cylinders of which exhaust (through a swivel pipe connection) to the smoke box, as usual. The high-pressure engine has piston valves, the low-pressure engine has slide valves. Both are fitted with the Walschaert outside valve gear. The reverse lever is arranged to be operated either by hand or by compressed air, as preferred. The high-pressure cylinders are provided with intercepting, reducing and high-pressure exhaust valves, permitting the use of live steam (at reduced pressure) in the low-pressure cylinders when circumstances require. This engine can be operated on curves of 20 degrees and upwards with great ease and with less frictional resistance than an ordinary consolidated engine of half its capacity. It is undoubtedly the largest and most powerful locomotive in the world at the present time, while many of its parts are lighter than those of ordinary heavy engines. This engine was in the Baltimore and Ohio Railroad Company's exhibit at the Exposition at St. Louis, Mo., in 1904, and at the present time it is doing very satisfactory work in heavy freight service on the Pittsburgh Division of the B. & O. R. R., between Confluence and Sand Patch.

GENERAL DIMENSIONS.

Type, 0660C334 mallet articulated.	
Guage of track	4 ft. 8½ in.
Loaded weight:	
On driving wheels	334,500 lbs.
Total engine	334,500 lbs.
Wheel base:	
Driving	10 ft. and 10 ft.
Total of engine	34 ft. 8 in.
Total of engine and tender	64 ft. 7 in.
Cylinders:	
Diameter	20 in. and 32 in.
Stroke of pistons	32 in.
Valves—H. P., Piston; L. P., Slide.	
Wheels:	
Diameter of driving wheels outside	56 in.
Diameter of tender wheels	33 in.
Journals—diameter and length:	
Driving	9 in. x 13 in.
Tender	5½ in. x 10 in.
Boiler:	
Type, straight top radial stay.	
Outside diameter at front end	84 in.
Length of fire box inside	108 in.
Width of fire box inside	96 in.
Number of tubes	436
Diameter of tubes	2½ in.
Length of tubes	21 ft.
Working pressure per sq. inch	235 lbs.
Heating surface in tubes	5,366.3 sq. ft.
Heating surface in fire box	219.4 sq. ft.
Total heating surface	5,585.7 sq. ft.
Grate area	72.2 sq. ft.

Tender capacity:	
Water	7,000 gallons.
Fuel	13 tons.
Clearance limitations:	
Height of stack above rail	15 ft.
Width	10 ft. 5 in.
Length over all	79 ft. 6½ in.



REDUCING VALVE.

AIR SIGNAL.

Q. What will cause the whistle to sound every time the brake is released?

A. The reducing valve stuck open, or dirt on its seat.

Q. How should a test be made to determine at what pressure the reducing valve operates?

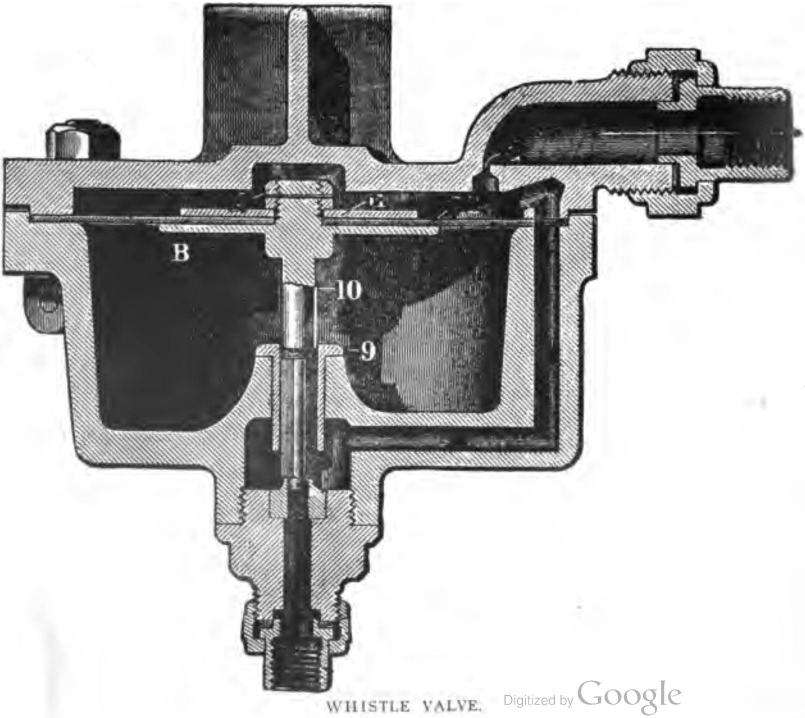
A. Shut off the pump, reduce the main reservoir pressure about 5 pounds at a time through brake valve till the signal whistle blows.

Q. If the air signal whistle only gives a weak blast, what is the cause?

A. The reducing valve is out of order so that the pressure is less than forty pounds; or, the whistle is filled with dirt, or not properly adjusted; or, the port under the end of signal valve is partly closed by gum.

Q. If the whistle fails to respond to action of the car discharge valve, where is the cause?

A. This indicates a signal valve having a stem (10) which is too loose a fit in bushing (9); or, if the diaphragm gets



WHISTLE VALVE.

bagged down, the pressure in cavity B will raise the baggy part of the rubber, and will not raise valve off seat. If the whistle fails to sound on a train of average length, but works all right on one or two cars, it indicates a too loosely fitted diaphragm stem in the signal valve.

Q. If the whistle gives too many blasts for one pull of the whistle cord, where is the cause?

A. This indicates diaphragm stem on which the groove does not go down far enough into the bushing.

Q. If the whistle gives one long blast for two or more pulls of the whistle cord, where is the cause?

A. This indicates a stem that fits too tight, the trouble being caused by a failure of the valve to open promptly, and being sluggish in closing.

Q. If the signal whistle blows frequently when not in use, where is the cause?

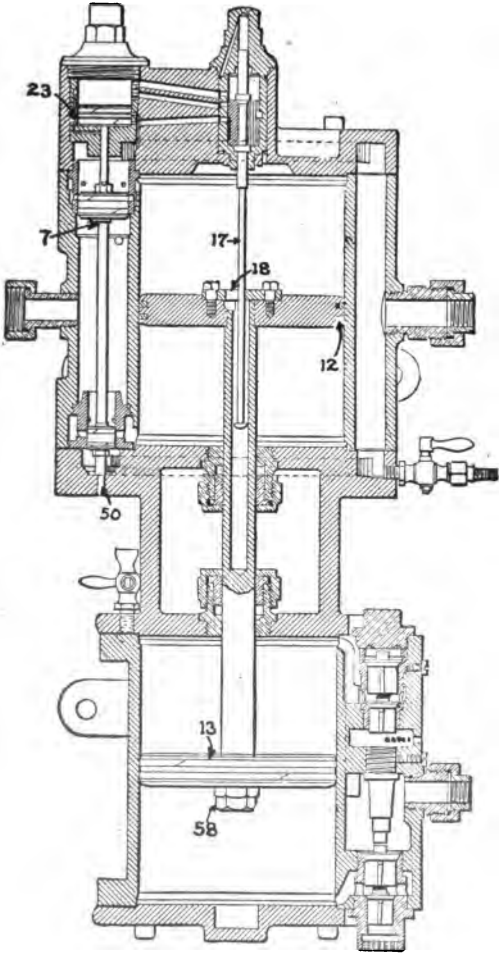
A. There is a leak somewhere, which the jar of the engine may open for an instant; or, the reducing valve may be out of order; if it sticks a little in its seat, as in cold weather, a very small leak will cause the whistle to give a strong blast.

Q. How can a test be made to determine if there is a leak in the air signal train line?

A. Close the cut-out cock near the reducing valve, and the whistle will sound as soon as the leak reduces the pressure.

Q. If the air signal train pipe fails to charge, where is the trouble?

A. If the angle cocks are open on each side of the hose between the tender and the cars, if the weather is not cold, it is most liable to be caused by the opening in the plug in the reducing valve, where the main reservoir pipe connects to it, being stopped up with gum; if the weather is cold, the reducing valve or pipe may be stopped with ice.



AIR PUMP—EIGHT-INCH.

AIR PUMPS—EIGHT-INCH.

Q. What will cause an 8-inch pump to pound?

A. Water in the cylinder; if the stop pin 50, the valve 7 or the stem of reversing piston 23 is too long, it may make the main valve strike the stop pin, and cause a pound; shoulder or button on reversing rod 17 or plate 18 being badly worn, allowing the main piston to strike either cylinder head before reversing, will cause a heavy pound; the nut 58 working loose and striking air-cylinder head; air valves pounding on their seat, due to too much lift; pump being loose on the bracket.

Q. What will cause an 8-inch pump to stop so that it can not be started by tapping on it?

A. Reversing rod 17 or stop pin 50 being broken; plate 18 loose; nut 58 coming loose and falling in such a position as to prevent piston from coming down far enough to reverse.

Q. What will cause an 8-inch pump to stop so that tapping on it will start it?

A. Lack of oil in steam valves; badly worn packing rings on main steam valve 7 or reversing piston 23. Reversing piston rod 23 breaking off just where it joins the piston. In all cases when the pump stops, ascertain whether the governor caused it to stop, by unscrewing the union nut between the governor and pump, and see if the steam passes freely through the governor.

Q. What will cause a pump to overheat?

A. The use of too much oil; badly worn packing rings; cylinder worn out of true; discharge valve broke or stuck open; continuous high speed; excessive pressure to work against; receiving valves stuck shut.

Q. How can the condition of the packing rings (13) in air cylinder be tested?

A. By taking off the lower head and working the pump very slowly, holding a light under piston head.

Q. In case there is no air taken in at receiving valve when the pump is working, how can it be determined if it is caused by the receiving valve stuck shut or discharge valve broke or stuck open?

A. By starting the pump when there is no air in it. If it is the discharge valve broke or stuck open, air will be received the first stroke; if it is receiving valve stuck shut, it will not take any air in.

Q. What will be the result if the air valves have too much lift?

A. Will cause the pump to pound and damage the valves and seats, and cause them to leak.

Q. How much lift should the air valves in an 8-inch pump have?

A. The receiving valves ⅛, the discharge valves 3-32.

Q. How should a test be made for leaky discharge valves?

A. This will cause the pump to heat. There will be no suction for that end of the pump cylinder; the stroke of the pump will be uneven, the one toward the defective valve being the slowest. If the upper discharge valve leaks, it will cause a continuous discharge of air from the air-cylinder oil cup; if the lower discharge valve leaks, it will cause a continuous discharge of air from the plug hole in the lower cylinder head.

Q. How should test be made for leaky receiving valves?

A. Start the pump; hold light to the air inlet of the valve to be tested. If air escapes when the piston is traveling toward the valve, it leaks.

Q. How should a test be made to determine the condition of the steam piston packing rings 12?

A. Start the pump at about 45 strokes per minute, and listen to the exhaust. If there is a constant heavy blow, packing rings are leaking.

DRAINING RESERVOIRS.

Q. How often should the main reservoir, equalizing and auxiliary reservoirs be drained?

A. At the end of each trip in cold weather, to prevent freezing up; once a week in warm weather.

AIR PUMP—NINE AND ONE-HALF INCH.

Q. What will cause a 9½-inch pump to stop so that it can not be started until repaired?

A. Broken or bent reversing rod 71; reversing plate 69 coming loose; nut 68 in air cylinder coming loose and falling in such a position as to prevent piston coming down far enough to reverse.

Q. What will cause 9½-inch pump to stop so that it can usually be started by shutting off steam and allowing all the steam in the cylinder to escape, and then opening the pump throttle?

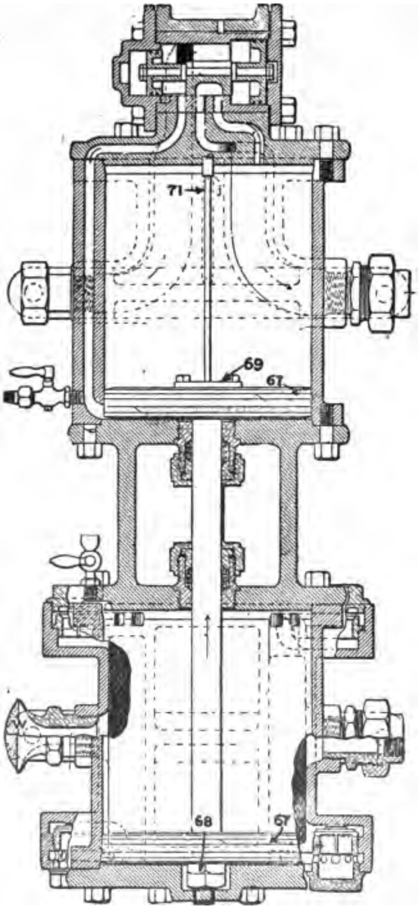
A. A leak between the steam passage and the upper end of the steam cylinder, due to a defect in copper gasket between the head and the cylinder.

Q. If a 9½-inch pump stops, how can it be determined whether it is the governor that caused it?

A. Open the drain cock of steam cylinder, and if steam escapes freely, the governor is not the cause.

Q. What will cause a pound in 9½-inch pump?

A. Nuts 68 on main piston 65 working loose and striking air-cylinder head; water in cylinder; pump being loose on bracket or bracket loose on boiler; receiving valves that are



AIR PUMP—NINE AND ONE-HALF INCH.

stuck, broken or leaking badly; reversing plate 69 or button on reversing rod 71 worn so that the pump is not reversed in time to prevent the piston striking the head. Air valves may pound on their seats, due to too much lift.

Q. How should a test be made for leaky receiving valves in 9½-inch pump?

A. Run the pump slowly and place hand over the inlet port. The suction will be less on the stroke towards the leaky valve—the stroke towards the leaky valve will be quicker.

Q. How should a test be made to determine whether a receiving valve is stuck shut, on a 9½-inch pump?

A. Start the pump slowly, holding a light to the inlet port. If valve is stuck shut there will be no suction on the stroke from that valve.

Q. What should be the lift of both receiving and discharge valves in a 9½-inch air pump.

A. 3-32 of an inch.

Q. How should a test be made to determine the condition of main steam piston packing rings 67?

A. Start the pump at about 45 strokes per minute, and listen to the exhaust; if there is a constant heavy blow the packing rings are leaking.

Q. How should a test be made to determine the condition of the packing rings 67 on main piston in air cylinder?

A. Take off the bottom head; start the pump very slowly; hold a light under piston.

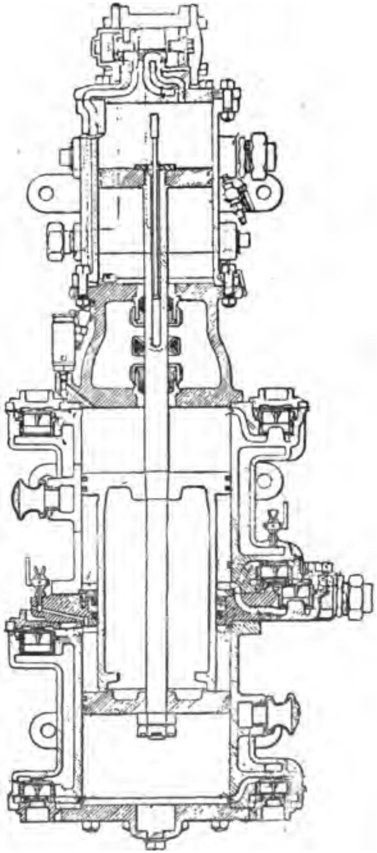
Q. What effect will leaky discharge valves have on the working of a pump?

A. It will cause the pump to heat and have an uneven stroke. If it is the upper discharge valve stuck open or leaking, it wlil be indicated by a constant blow out of the air cylinder oil cup; if it is the lower discharge valve, it will cause a constant blow out of the plug hole in bottom cylinder head.

TANDEM COMPOUND PUMP.

The air end only is compound. The additional features required are so similar to the old standard that the simplicity of operation is assured. Generally speaking, the compounding of the air end is done as follows: The two air cylinders are of the same diameter, each having a piston suitably connected to the piston rod, which is actuated by the steam piston. These two air pistons are further connecteed by a drum of smaller diameter than the inside diameter of the air cylinders, in such a manner that the two pistons and drum form a sort of a spool. The center piece between the air cylinders fits closely about the spool, and has packing rings to prevent the passage of air from one cylinder to the other past the surface of the drum. The low-pressure air is drawn into the top of the upper cylinder and the bottom of the lower cylinder, and, during compression, is forced through suitable valves and passages to the annular volume formed between the spool and air-cylinder walls and center piece. The final compression takes place in this annular volume, and the air is forced out through the passage and valves in the center piece to the discharge opening. It will thus be observed that in each air cylinder both high and low pressures are single acting, but that those pressures on the air piston, as a whole, are double acting. The resultant effect, therefore, on the steam piston rod is almost the same as in the simple pump: by this compounding the air end, a much smaller steam cylinder can be used to operate the pump.

The present design of pump consists of a steam cylinder, 8 inches in diameter by 12-inch stroke, and two air cylinders,



TANDEM COMPOUND PUMP.

11 inches in diameter by 12-inch stroke, while the small diameter of the spool is 8¾ inches. It is made for a capacity similar to that of the standard 11-inch pump, which has been on the market for some years, having air and steam cylinders each 11 inches in diameter by 12-inch stroke. Consequently, the compound pump has an 8-inch diameter cylinder instead of an 11-inch, as with the standard, and the steam consumption is thereby reduced to about 52 per cent. of the latter through this change alone, but, by compounding the air end, the capacity of the pump is increased about 16 per cent. when pumping against 90 pounds air pressure, due to the fact that the low-pressure clearance volume at the end of a compression stroke is filled with air at only about 40 pounds pressure instead of 90 pounds.

The air valves, valve seats and valve cages are of the same pattern as those used in the 11-inch pump, while the steam valve mechanism corresponds exactly with that of the 9½-inch pump. Also, the piston rings of the two air pistons are similar to the 11-inch pump, and the steam piston rings correspond to the old standard 8-inch pump.

The same defects will cause the pump to pound or stop that will cause the 9½-inch to pound or stop. Test for leaking piston packing ring in steam cylinder the same as with a 9½-inch pump. Also, for stuck, broken or leaking air valves.

EIGHT AND ONE-HALF INCH CROSS COMPOUND PUMP.

The valve gear and its operation is essentially the same in this pump as in the 9½-inch and 11-inch pumps. The reversing valve performs the same duties and is operated by the reversing-valve rod in the same manner as that of the 9½ and 11-inch pumps. The main slide valve is provided

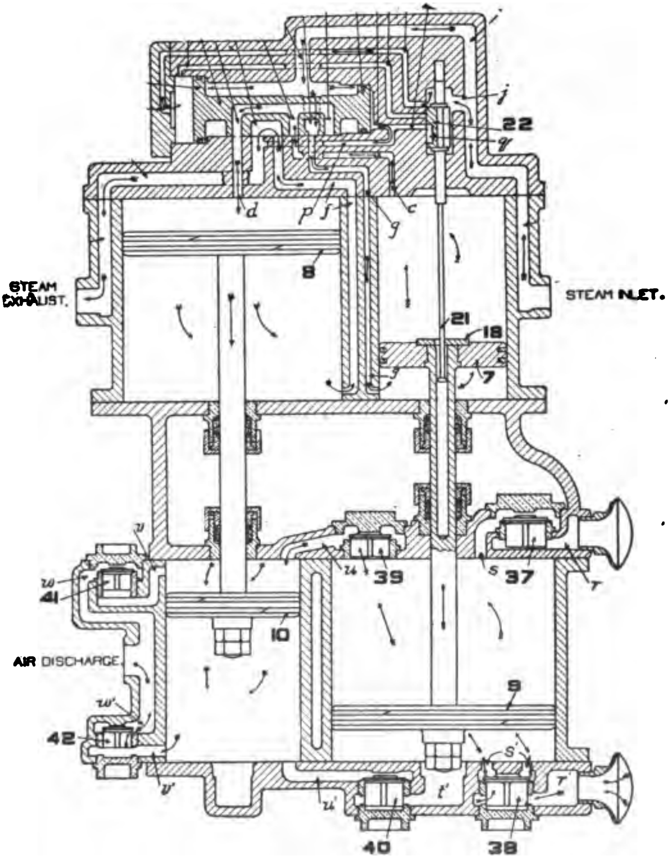


DIAGRAM OF THE CROSS COMPOUND PUMP UP-STROKE, HIGH-PRESSURE-STEAM SIDE with the usual exhaust cavity, and in addition has four enlongated steam ports in its face. The two outer and one intermediate ports communicate with two cored passages extending longitudinally in the valve and serves to make the proper connection between the high and low pressure cylinders during the expansion of steam from one to the other. The remaining ports control the admission of steam to the high-pressure cylinder. The arrangements of the ports is such as to have a balancing tendency to the slide valve, thereby acting as a preventative of uneven wear of the valve face and seat. The cavity governs the exhaust from the low-pressure cylinder to the atmosphere.

The valve seat has five ports: of those the two back ones lead to the bottom and top ends respectively of the high-pressure cylinder; the first and third ports to top and bottom ends of the low-pressure cylinder and the second port to the exhaust. While steam is being admitted to the bottom end of the high-pressure cylinder, carrying its piston upward, the main slide-valve cavity opens the bottom end of the low-pressure cylinder to the exhaust and at the same moment its cored passage connects the top end of the high and low-pressure cylinders, thus expanding the steam from above the high-pressure piston to the top end of the low-pressure cylinder, moving the piston of the latter downward. During this time free air is being taken into the bottom end of the low-pressure air cylinder, while that in the top end is being compressed into the high-pressure cylinder. During the piston stroke this intermediate pressure is being built up from atmoshpere to about 40 pounds, a result of compressing the air from the large into the small air cylinder, a similar increase is taking place above the high-pressure air piston and which exerts a downward force on that piston the same as does the steam above the low-pressure steam piston. On the opposite or lower side of the high-pressure air piston the intermediate air under compression to the main reservoir is exerting a resistance equal to the area of the piston plus the main reservoir pressure and which is greatly less than the combined steam and air pressure on top of their respective pistons. When the pump is reversed the action is simply a repetition of that above described. The low-pressure steam and high-pressure air pistons are connected by a solid piston rod, having no mechanical connection with the valve gear, being simply floating pistons. The tendency of packing-ring leakage is largely reduced in all cylinders, a result of less differential pressure on opposite sides of the pistons and which can not be provided for in simple or duplex pumps.

If this pump stops and can not be started look for the trouble in high-pressure steam cylinder at reversing rod No. 21 or plate 18; if not found there examine low-pressure air cylinder, see if the nut on main piston has not worked off and fallen in such a way as to prevent the piston coming down far enough to allow it to reverse.

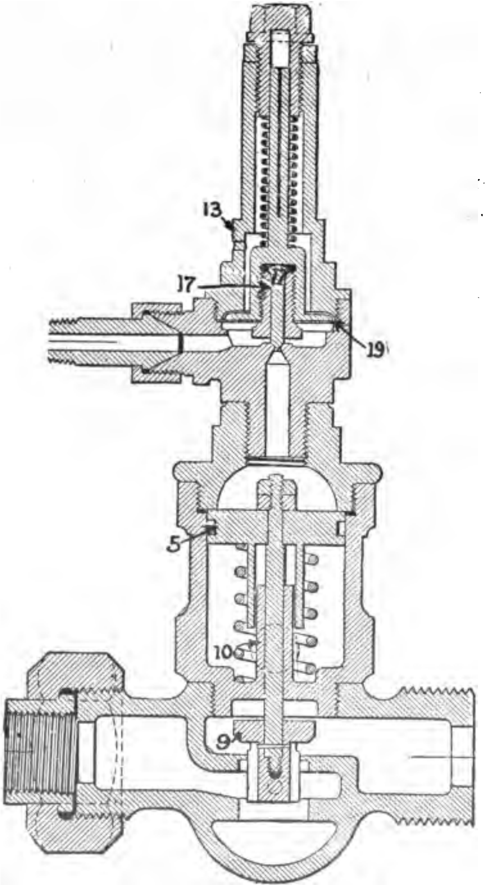
Test for stuck shut or leaky receiving or discharge valves of the low-pressure air cylinder the same as with the 9¾-inch pump.

AIR PUMP GOVERNORS—OLD STYLE.

Q. What effect will a buckled diaphragm in an old-style governor have on the working of a pump?

A. It causes the governor to lose control of the pump. It is liable to stop the pump before maximum pressure is obtained, or allow the pump to pump more than the pressure allowed before stopping it.

Q. If the governor fails to stop the pump, where is the trouble?



AIR PUMP GOVERNORS—OLD STYLE.

A. The small vent hole in the side of the cap 13 is stopped up, permitting the accumulation of air above the diaphragm; the exhaust 10 may be stopped up or frozen; piston 5 may be stuck in some manner; or the brass backing above the diaphragm 19 may be too thick, preventing the valve from raising; or steam valve 9 held from its seat by dirt.

Q. What will cause the governor to stop pump at about 40 pounds pressure?

A. Pin valve 17 being too short, or from any cause held from its seat.

Q. In the event of a governor failing to stop pump when the proper amount of pressure is pumped, what should be done?

A. If the governor can not be repaired, control the pump with pump throttle to prevent overcharging.

Q. What should be done in the event of the governor stopping the pump before the proper amount of pressure is reached?

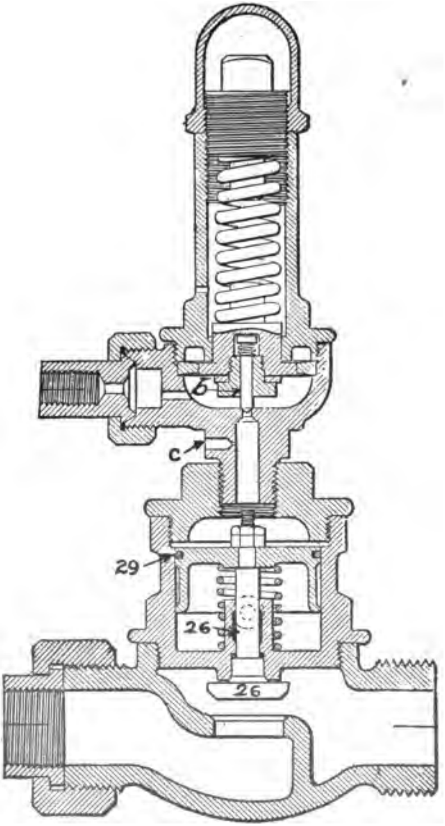
A. Cut the governor out by placing a blind gasket in joint of the pipe between brake valve and governor. Control pump by throttle.

AIR PUMP GOVERNOR—IMPROVED.

Q. What is one of the most common causes of governors failing to stop the pump when the maximum pressure is obtained?

A. The use of too much oil in the air cylinder of pump. The air valve gets gummed up where it rests on its seat, so air can not get through after air valve raises. To cure this trouble, take out the diaphragm, and clean off air valve and its seat.

Q. What effect will a leaky pin valve *b* in an improved



AIR PUMP GOVERNOR—IMPROVED.

governor have on the working of the pump, and how will it be indicated?

A. It will cause the governor to be less prompt in starting the pump after the pin valve is seated. It will be indicated by a constant discharge of air from the relief port *c*.

Q. What effect will the drip pipe that is frozen or stopped up have on the working of the pump if the stem of steam valve 26 is worn enough to cause it to leak?

A. Steam will feed up into chamber under the governor piston, and prevent the piston from being forced downwards to close the steam valve 26; the pump will continue to work until sufficient pressure is accumulated to stop it. A worn steam valve stem will be indicated by steam escaping from the drip pipe.

Q. What will cause the governor to not work at all?

A. Pin valve *b* held on its seat by spring box. To test for this, slack off on the spring box, and see if the governor will work.

Q. What is liable to stick the governor piston, at the lower end of its stroke, so the pump will not start?

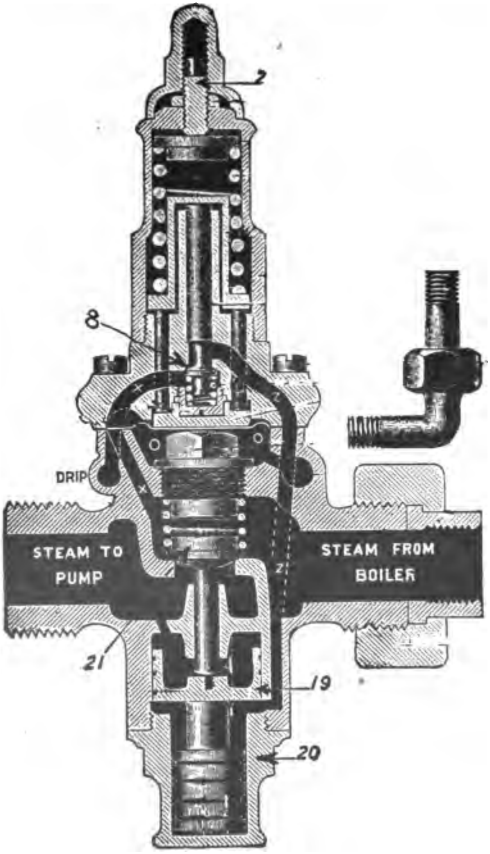
A. Badly worn bushing in which the governor piston works, will cause this. A light tap on the governor will usually cause the governor to operate.

Q. What effect will relief port *c* being stopped up have on the working of the pump?

A. It will cause steam valve 26 to be held on its seat for some time after pin valve has seated, and pump will not start. In this case, the air that has forced steam valve to its seat has no way to escape only by leaking past packing rings 29, and out drip pipe.

Q. If relief port *c* becomes stopped up, out on the road, how can it be opened?

A. It can be opened with a fine sewing needle.



THE MASON AIR-PUMP GOVERNOR.

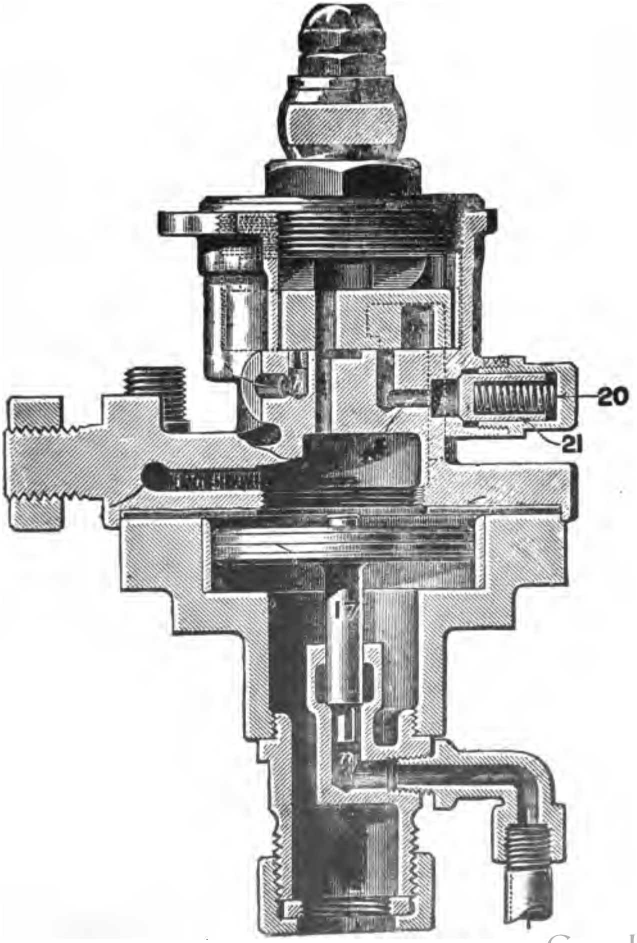
THE MASON AIR-PUMP GOVERNOR.

Q. What will cause the Mason governor to refuse to stop the pump when the required pressure is reached?

A. This is usually caused by main valve 21 being held off its seat by dirt or scale, or steam pressure under piston 19. If it is caused by steam pressure under piston 19, the trouble is caused by valve 8 not seating. In this governor, the operative fluid pressure—that which moves the piston to stop the pump—is steam. If valve 8 does not seat properly, the steam pressure under piston 19 will hold main valve 21 off its seat, and the governor will not control the pump. If this trouble can not be remedied with tension screw 2, the pump will have to be controlled with the throttle the rest of the trip.

Q. What will cause the Mason governor to stop the pump before the required pressure is reached, and not let it start?

A. Main valve 21 has closed and failed to open. Some defect is holding the piston 19, which operates it, from moving. The piston 19 is intended to be moved by steam pressure through an opening controlled by the valve 8; this valve (8) is controlled by air pressure; if valve 8 is stuck shut, steam pressure cannot pass to the lower side of piston 19 to force main valve 21 off its seat. Sometimes piston 19 will get stuck in its bushing or the dash-pot extension, caused by corrosion. With trouble of this kind, if you can not get the pump to start by tapping on the side of the governor, it will be necessary to remove the dash-pot nut 20; place a piece of wood under piston 19, to hold main valve 21 off its seat; replace nut 20, and control pump with the throttle.



BRAKE VALVE D 8.

BRAKE VALVE D 8.

Q. If the brake valve fails to maintain excess pressure when valve is in running position, both hands remaining together, where is the trouble?

A. Leaky rotary valve, dirt on the seat of excess pressure valve 21, or spring 20 is too weak or broken.

Q. If excess spring 20 is too strong, what should be done?

A. File a piece off the end.

Q. If excess spring 20 is too weak or broken?

A. Force a small piece of wood into the valve 21, so as to partially fill it; this will help to strengthen the spring.

Q. How should the excess pressure spring 20 be tested?

A. Place the valve handle in running position, start pump. If the red hand goes up 20 pounds in advance of the black hand, the spring is right.

Q. How will a leak between the brake valve and equalizing reservoir or gauge be indicated?

A. Will cause a blow from the train pipe exhaust valve when the brake valve is in lap position. The longer the train pipe is, the stronger the blow will be.

Q. In case there is a leak in equalizing reservoir or pipe leading to it, that can not be repaired, what should be done?

A. Place a blind gasket in the pipe union near the brake valve; plug the train pipe exhaust elbow; use the brake valve, in emergency, carefully. If leak is in pipe to gauge, put a blind gasket or plug in it.

Q. How should a test for a leaky rotary valve be made?

A. If there is a cut-out cock under brake valve in train pipe, close it, and start the pump with brake valve handle in lap position. A leaky rotary will cause a blow at the train pipe exhaust, and will be indicated by the black hand. If there is no cut-out cock under brake valve in train pipe, place the brake valve handle in lap position (be sure that there is and, when there is 90 pounds in main reservoir, open the angle no air in train pipe or auxiliary reservoir); start the pump, cock at rear of tank, holding the end of hose in a bucket of water. A leaky rotary will be indicated by bubbles rising in the water.

Q. Why should a D 8 brake valve never be left on lap position when the engine is coupled to a train, or at any time?

A. When the valve handle on a D 8 valve is placed on lap position, the governor is cut out, and the pump will continue to work until it has accumulated pressure enough to stop it. If, for any reason, this has been done, there should be two or three applications made before the train pipe is allowed to charge, to prevent overcharging the train line.

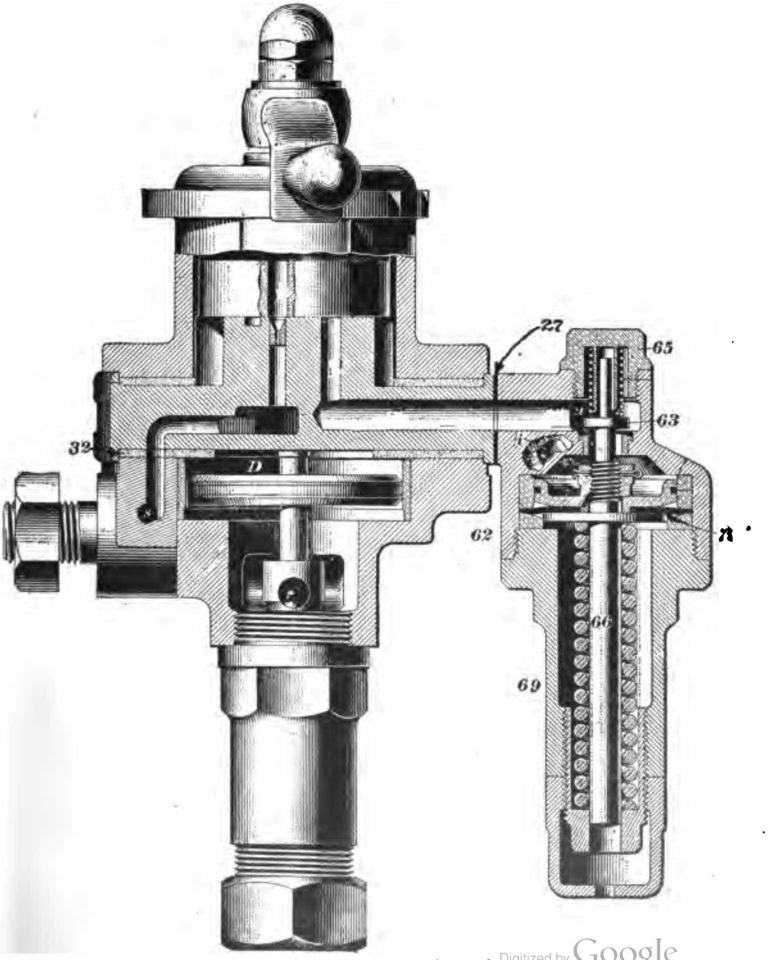
BRAKE VALVES—D 5, E 6, F 6, G 6.

Q. If, with D 5, E 6, F 6, G 6 brake valve, the brake would not go on in service application, nor the black hand fall, and the train pipe exhaust would not open while air came readily from the preliminary exhaust, where is the trouble?

A. Leaking at join on lower gasket 32. A leak here will allow air to get from main reservoir direct to cavity over equalizing piston. This will give main reservoir pressure to chamber D, and will show it on black hand. With this leak there will be no excess pressure. To apply brakes, use direct application port, opening and closing it slowly.

Q. How should a test be made for a leaky gasket 32?

A. Place the brake valve on lap; if the gasket leaks, the black hand will move up rapidly towards the red hand. A leak through rotary valve or the gasket 32 can be readily distinguished from a leak in feed valve case gasket 27 or supply valve 63, since the former are constant, while the two latter occur only when the brake valve is in running position.



BRAKE VALVES—D 5, E 6, F 6, G 6.

Q. If there is a constant blow at the train pipe exhaust of the brake valve, where is the trouble?

A. Stuck or leaky equalizing piston, dirt on its valve seat, or a bad leak in pipe to equalizing reservoir or gauge. Try putting brake valve on lap, then on emergency, then back to full release, and see if this will stop it.

Q. How should a test be made for a leaky rotary valve on the D 5, E 6 and F 6, G 6 brake valves?

A. The same as on the D 8 brake valve.

Q. What effect will a leak in feed valve case gasket (27) have on the excess pressure?

A. If there is a leak in gasket between ports f and i, there will be no excess pressure, as the main reservoir pressure can pass to train pipe without going through feed valves. Sometimes the leak can be stopped by tightening the nuts of the feed valve studs. If it can not be stopped in this way, replace the gasket with new one, if there is one on the engine; if not, make one out of cardboard or an old felt hat. This applies to both F 6 and slide valve feed valves.

Q. In the event of a leak in equalizing reservoir, or pipe from brake valve to reservoir, or pipe to gauge, how should it be cut out?

A. The same as with brake valve D 8.

Q. If, in service reduction, the pressure in equalizing reservoir and chamber D can not be reduced from 70 to 50, through the plug in preliminary exhaust port, in about 5 seconds, where is the trouble?

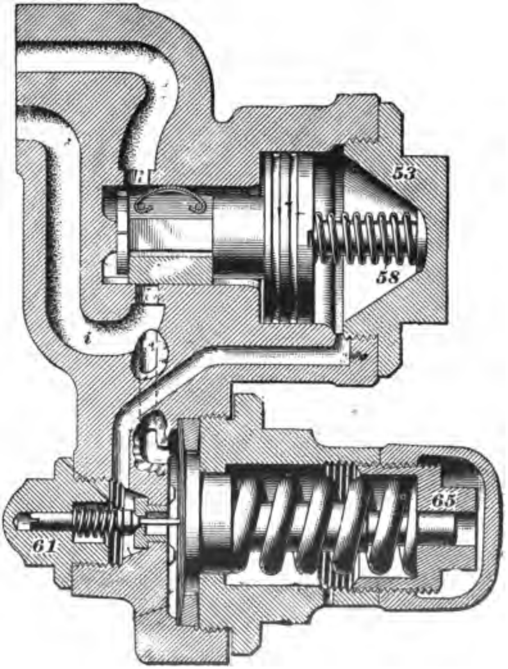
A. Either the size of this passage is reduced with gum or dirt, or equalizing piston packing rings leak, or gasket 32 leaks.

Q. If the pressure in equalizing reservoir and chamber D reduce too quick through preliminary exhaust, where is the trouble?

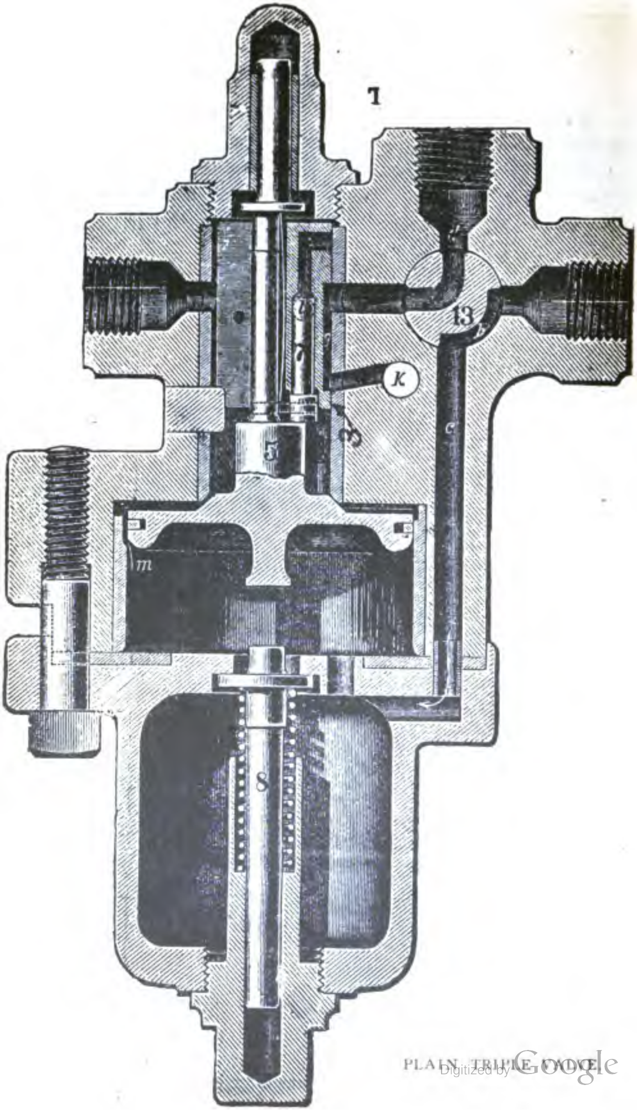
A. A leak in equalizing reservoir or pipe connections from brake valve, or equalizing reservoir partly filled with water.

Q. If the train-line pressure exceeds the maximum, and can not be adjusted to carry the proper amount when the brake valve is in running position with the regulating spring in the F 6 feed valve, where is the trouble?

A. If in the brake valve, the rotary valve leaks; or gasket 32 leaks; or it may be feed valve case gasket 27. If in



SLIDE VALVE FEED VALVES.



PLAIN TRIPLE VALVE.

the feed valve, supply valve 63 is held off its seat by dirt or gum; or stem of valve 63, that runs up into cap nut 65, is bent so the valve will not come down squarely on its seat; or valve cut so as to cause a leak. If the spring case 69 is screwed up too far into the valve body 62, the edge of the larger gasket will be mashed out thin, the two gaskets will then fill the recess in 75 and hold the piston up and valve 63 open.

Q. With the slide valve feed valve, what will cause the train-pipe pressure to get too high?

A. Regulating valve leaking, either of the cap nuts (53 or 61) leaks, or the spring 58 is too weak or broken. If the opening by the seat of the regulating valve is stopped up, or the regulating spring in cap nut 61 is too weak, the slide valve will be closed. Regulate with tension screw 65.

Q. How can a test be made for leak on the engine equipment?

A. When full pressure is obtained—70 pounds train line, 100 pounds main reservoir—stop the pump, place the valve in lap position. If the red hand drops and the black hand remains at the 70, there is a leak somewhere in the main reservoir line, which begins at the discharge valves in the pump, and ends at top of rotary in brake valve. If the black hand drops back, there is a leak in the train line.

PLAIN TRIPLE VALVE.

Q. What will cause a blow at the exhaust port of a plain triple?

A. Leaky side valve 3 or a leak past the plug cock 13. To determine which is causing the blow, apply the brake lightly; if it is the plug cock, the blow will stop; if it is the side valve, it will continue.

Q. How should a test be made for a leaky graduating valve 7?

A. Apply the brake with a light application; if the graduating valve is leaking, the brake will release through exhaust port or triple about as quick as the valve is lapped. After recharging the auxiliary, set brake with full application, and brake will stay set.

Q. How can it be determined whether the triple piston packing rings are leaking, without taking down triple?

A. Apply the brake by making a 15-pound reduction, and then gradually open the release valve on the auxiliary reservoir on the defective brake a very small amount, so that a slight discharge takes place; if the brake does not release within 15 seconds, open the release valve a very little more, so as to increase the discharge; continue to increase the discharge every 15 seconds until the brake does release. Then the rate at which air is escaping through the release valve is slightly greater than that past the triple piston packing ring, as the auxiliary reservoir pressure had to be reduced in order to release brake.

Q. Why does the tender brake sometimes stick and refuse to release until auxiliary is bled, when all the other brakes release promptly?

A. Generally, because there is not enough excess pressure carried. A great many tenders have 12 by 33-inch auxiliary reservoirs for an 8-inch brake cylinder. If in this case the piston travel is short, the brake cylinder pressure is 6 or 7 pounds higher than other brakes equalize at, and train pipe pressure must be raised correspondingly higher to release tender brakes. The tender triple gets more sand and dirt in it than any other triple, which causes it to wear and leak; and especially the triple piston packing ring gets to leaking, and this will cause any brake to stick unless very high excess is used.

Q. What will cause driver brake to not release when brake valve handle is placed in release position?

A. Worn triple piston packing rings: the leakage past the packing rings may allow auxiliary pressure to equalize with train pipe, without moving triple to release position. Or exhaust port in triple may be stopped up, or release spring too weak or broken; or, if with cam brake, piston travel may be so long that the brakes lock against the drivers.

Q. What will cause a driver brake to release soon after being applied.

A. A leak in the auxiliary reservoir or its connections, or a leaky graduating valve in the triple, or leaky rotary valve in brake valve, or a leak in piston packing leather or piston rod packing.

Q. What will cause a tender brake to release soon after being applied?

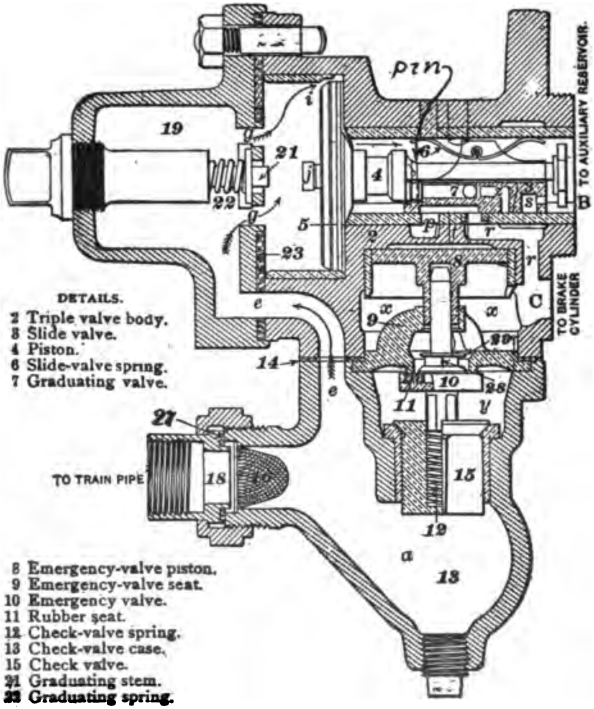
A. A leaking auxiliary reservoir or its connections, or leaky rotary valve or leaky graduating valve in triple valve, or leaky brake cylinder packing leather.

Q. How should a test be made for leaks in driver and tender brake cylinders and connections?

A. Set the four-way cock in plain triple for straight air. This will give time to look for leaks. If packing leather leaks in cylinder of push-down driver brake, air will blow out of hole in the spring case or lower head; if in a pull-up driver brake, will blow around piston rod or out of vent hole in top head. If packing leather in tender or car brake cylinder leaks, air will blow out past sleeve.

Q. How can the brake on engine and tender be cut out without interfering with the train brakes?

A. By turning the four-way cock in top of plain triple so the handle is at an angle of forty-five degrees. In the



DETAILS.

2 Triple valve body.
3 Slide valve.
4 Piston.
6 Slide-valve spring.
7 Graduating valve.

8 Emergency-valve piston.
9 Emergency-valve seat.
10 Emergency valve.
11 Rubber seat.
12 Check-valve spring.
13 Check-valve case.
15 Check valve.
21 Graduating stem.
22 Graduating spring.

QUICK-ACTION TRIPLE VALVES.

latest type of engine triples, the cut-out cock is in the crossover pipe. With either, when brake is cut out, open bleed valve in auxiliary reservoir.

QUICK-ACTION TRIPLE VALVES.

Q. What will cause a blow at the exhaust port or pressure retainer of a quick-action triple valve?

A. Imperfect fit of the slide valve (3) on its seat, or dirt between slide valve and seat, or leakage past the narrow bridge that divides the reservoir and cylinder passage, in the gasket (15) between the triple valve and the part to which it is attached. In freight equipment the triple valve is attached to auxiliary reservoir; in passenger, to brake cylinder. The blow is most liable to be caused by emergency valve 10, the bearing face of which, being rubber, will sometimes rot out from the action of oil. In many cases a little dirt under valve 10 will cause a sharp blow out of the exhaust. To determine which is causing the blow, turn the cut-out cock in crossover pipe: if the blow stops immedaitely and the brake sets, it is caused by emergency valve 10; if the blow continues for some time after cut-out cock has been turned, and gets weaker, and brake does not set, the trouble is in slide valve or gasket. If dirt on the seat of emergency valve (10) causes the blow, it can, in most cases, be removed by an emergency application.

Q. How should a test be made for leaky triple piston packing rings in a quick-action triple valve be made?

A. The same as in a plain triple valve.

Q. What will cause a quick-action triple to go into emergency when a service application is made?

A. The pin that holds graduating valve 7 to triple piston 4 being broken, or triple being dirty; or, with a short train, graduating spring 22 weak or broken.

Q. How should a test be made for a leaky graduating valve 7 in a quick-action triple valve be made?

A. The same as in a plain triple valve.

Q. If a quick-action triple valve will not release, and there is a blow at the triple exhaust or pressure retainer, where is the trouble?

A. Emergency valve 10 is held off its seat for some cause.

Q. How should a test be made for a leaky check valve (15) in a quick-action triple?

A. Reduce the pressure 25 pounds from 70; if the air comes out full and strong, and the equalizing piston seats in brake valve without a leak, make another reduction of 20 pounds; with this reduction the brake cylinder will have more pressure in it than the train pipe, and if any check valves (15) in triple valves leak, the air from brake cylinder will leak back into train pipe and increase the pressure under equalizing piston in brake valve to more than what is in chamber D and equalizing reservoir, and will unseat equalizing piston and cause a blow at the train pipe exhaust of the brake valve.

Q. If a pressure-retainer pipe is broke off, should it be plugged?

A. It should not under any consideration, for if it is stopped up, the brake can not be released.

Q. If a brake is defective and can not be used on a car, how should it be cut out?

A. Shut the cock between train pipe and triple valve in crossover pipe, and open bleed valve on auxiliary reservoir.

Q. How can a triple valve that goes into emergency for a moderate service reduction be located?

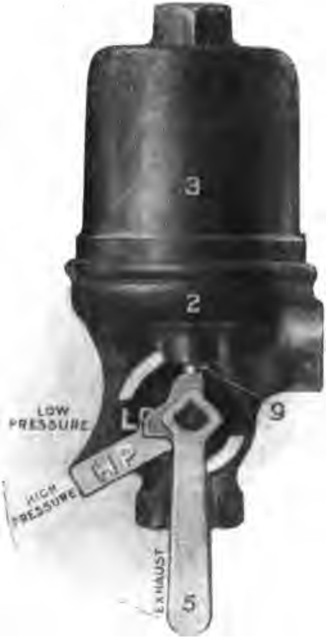
A. Use 8 or 10 cars; make a reduction of 6 pounds; cut out the brake that did not apply; then, after recharging auxiliary reservoirs, make a reduction of 8 pounds to see if the right car is cut out. A triple that goes into emergency will be the last one to release.

Q. If either the old-style or high-pressure pressure-retaining valves fail to hold air in the cylinder, where is the trouble?

A. This is generally due to a leak in the connecting pipe, a frequent seat of trouble being at the union. It may also be due to a leak in the brake cylinder or in the retaining valve, but seldom in the latter.

Q. How should a pressure-retaining valve be tested?

A. Turn the handle up, apply and release the brakes after



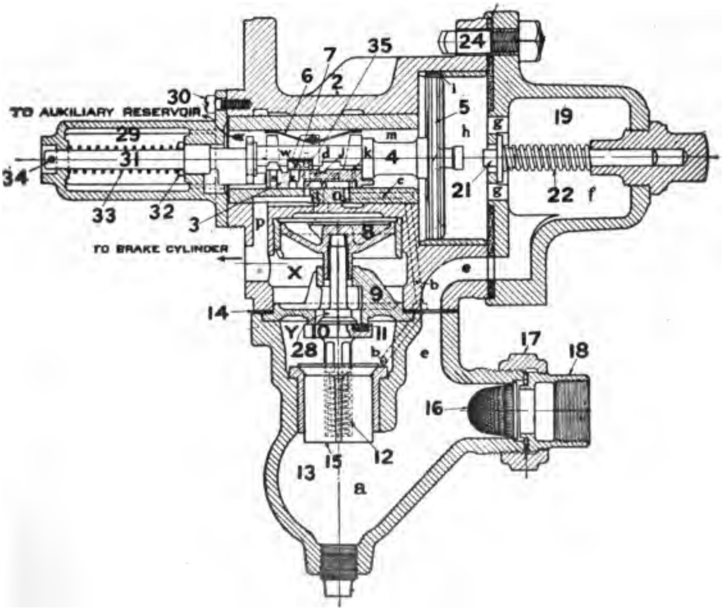
HIGH AND LOW-PRESSURE RETAINING VALVE.

air ceases to discharge from the retainer; in about two minutes turn the handle down, and if air discharges through the ports at the handle, the retainer is all right.

THE K 2 FREIGHT TRIPLE VALVE.

The K 2 freight triple valve is similar in general appearance to the H 2 (H 49) quick-action freight triple used in connection with 10-inch brake equipments and can be used to replace the latter on a car as the supporting flange and pipe connection dimensions are the same. The K 2 triple performs all the functions of the older forms of freight triple valves, and in addition several other functions which automatically overcome the serious difficulties incident to the operation of trains consisting of from 50 to 100 air braked cars all fitted with the triple valves now in general use. The difficulties in question and methods of correcting them are, first: the failure of a percentage of the brakes in a long train to apply. This is caused by a back flow of air from the auxiliary reservoir to the brake pipe through the feed groove, and leakage from the brake cylinder to the atmosphere through the leakage groove. It is the result of the comparatively slow brake-pipe reduction which must be made with such trains to prevent the forward brakes building up braking power so much more rapidly than those in the rear as to create buffing strains which will always be severe and under some conditions destructive to draft rigging and cars.

This difficulty is corrected by adding to the triple valve, ports and passages controlled by the slide valve and graduating valves so arranged as to vent brake pipe pressure into the brake cylinder while the brakes are being applied, thus reproducing to an extent, during service applications, the action of the standard triple valve in quick action. This very materially reduces the volume of air to be discharged by the brake valve, and rapidly transmits the reduction started with the brake valve from one triple valve to another seriately throughout the train, resulting in a rapid reduction of brake pipe pressure, thus insuring the application of all brakes and very materially reducing the interval of time elapsing between the service application of the front and rear brakes as compared with standard types of triple valves. Second: a complete release of the brakes at the front end of the train with standard brakes, before increase of brake pipe pressure,

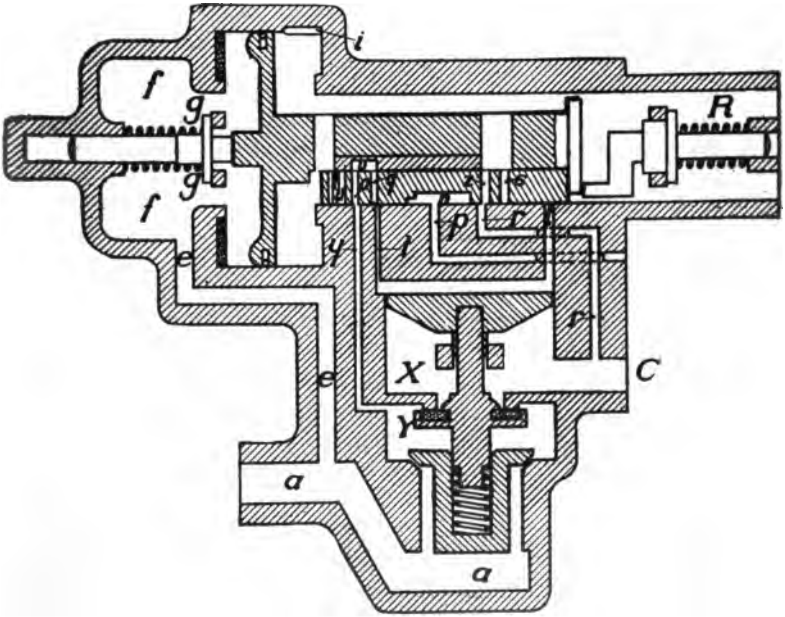


THE K 2 FREIGHT TRIPLE VALVE.

which has brought this about can reach the triple valves near the rear end, permits the slack to run out hard and create excessive strains on draft gear. This operation of the brakes is reversed by the introduction of an additional release position in the K 2 triple valve designated as the "Retarding Release" position, which can only be brought into use in the triple valves at the front end of the train. The area of the exhaust port in this position is so restricted as to produce a very slow release of brake cylinder pressure, thus retarding the release of the brakes on the front end of the train sufficiently to permit the rear brakes to begin to release while there is ample pressure retained in the cylinders at the front end to prevent the slack running out. Third: overcharging the auxiliary reservoir at the front end of a long train while releasing brakes, which results in a re-application of them when the brake valve handle is moved to running position. To prevent this the K 2 triple valve has an additional charging position in which the rate of re-charging the auxiliary reservoir is materially reduced in long trains. This restricted feed can only be obtained in the triple valves at the front end where the high and quick rise of brake-pipe pressure occurs and therefore is a very material aid in uniform re-charging of brakes.

THE K 2 FREIGHT TRIPLE VALVE IN FULL RELEASE POSITION CHARGING.

When this triple valve is in full release and charging, air from the brake pipe enters the triple at A, flows through passage E F G, chamber H and the feed groove I to chamber R and the auxiliary reservoir. The feed groove I is of the same dimensions as that of the standard H 1 (F 36) triple valve; therefore, it is necessary to increase the port area, through which air can feed into the auxiliary reservoir more rapidly and supply the greater volume required by the 10-inch brake cylinder. To accomplish this, port J in the slide valve registers with port Y. Air then passes from the brake pipe at A past the check valve into chamber Y through port Y and J to chamber R and the auxiliary reservoir. The combined capacity of feed groove I and port J is equivalent to the feed groove of the H 2 (H 49) triple valve.



SERVICE APPLICATION.

This figure is a diagramatic view of the K 2 triple valve in service position.

In making a service application, the piston and graduating valve move to the left, closing feed groove I and feed port J, preventing auxiliary-reservoir pressure flowing back into the brake pipe. The continued movement of the piston carries the slide valve to the left until the piston strikes the graduating stem, meantime closing the exhaust port P. The ports of the valve are then in service position, as shown in the figure, and auxiliary-reservoir pressure flows to the brake cylinder through ports Z and R. At the same time brake-pipe pressure at A passes the check valve into chamber Y and through ports Y and O into cavity V in the graduating valve, thence through ports Q and T past the piston of emergency valve, which is loosely fitted, into chamber X and the brake cylinder at C. While the flow of air from the brake pipe to the brake cylinder is not sufficiently rapid to caues an emergency application, it takes considerable amount of air from the brake pipe, thus increasing the rapidity with which the brake-pipe reduction travels through the train. As a result of venting brake-pipe pressure to the brake cylinder, only a small part of the reduction is made at the brake valve, each triple valve acting momentarily as a brake valve to increase the rate of reduction under each car, thus hastening the application throughout the train. This quick service feature decreases the time of full service application about fifty per cent. The brake-pipe reduction necessary at the brake valve is less for a certain brake cylinder pressure, due to the fact, first, that part of the reduction takes place at each triple valve instead of all at the brake valve, as with the former type of triples; and, second, that the air vented to the brake cylinder increases the pressure obtained in the latter so that a smaller brake-pipe reduction is required for a given cylinder pressure.

SERVICE LAP.

The piston being in the position shown in the figure, air flows to the brake cylinder through service ports Z and R from the auxiliary reservoir until the pressure is less than that of the brake pipe, when the piston moves the graduating valve to the right to lap position. Closing ports Z and O the relative area of the service application port Z and the quick service port O are such that the pressure in the auxiliary reservoir will always reduce more rapidly than brake-pipe pressure can by flowing through port O to the brake cylinder, making it impossible for the piston and graduating valve to remain in service position after the brake-pipe reduction to the atmosphere is stopped.

RELEASE.

The piston, slide valve and gaduating valve being in service lap position, raising the brake-pipe pressure above that in the auxiliary reservoir, moves these parts to the right to either full release or retarded relase position, dependent upon the excess of pressure in the brake pipe over that in the auxiliary reservoir. When the brake-pipe pressure is raised gradually, creating only a slight differential pressure on opposite sides of the piston, its movement is arrested in full release position by striking retarding-device stem 31; see first figure. In this position the maximum exhaust opening is obtained through port R, cavity N in the slide valve, and exhaust port P, at the same time the auxiliary reservoir is re-charged at the maximum rate through ports Y and J and feed groove I, as previously described. When the rise in the brake-pipe pressure is rapid enough to create a sufficient differential on the piston to compress retarding-device spring 33, the piston, slide valve and graduating valves are moved to the retarding-release position. At this time the piston is brought into contact with the end of the slide valve bush, making a tight joint so that no air can pass from the brake pipe through feed groove I to the auxiliary reservoir. In this position brake-cylinder pressure is exhausted through port R, cavity N and port P, but the latter port P is partially closed by the slide valve restricting the exhaust to a small area. This results in the auxiliary reservoir being slowly re-charged through ports Y and L, the area of the latter being about half that of feed groove I and much less than that of port J. As previously explained, the pressure in the brake pipe must raise at a more rapid rate than in the auxiliary reservoir in order to move the triple valve parts to the "retarded-release" and retarded-recharging position. This is possible in long trains only on about 30 cars at the front end, because the frictional resistance to the flow of air through the brake pipe prevents the building up of brake-pipe pressure in the balance of the train faster than it can flow into the auxiliary reservoir.

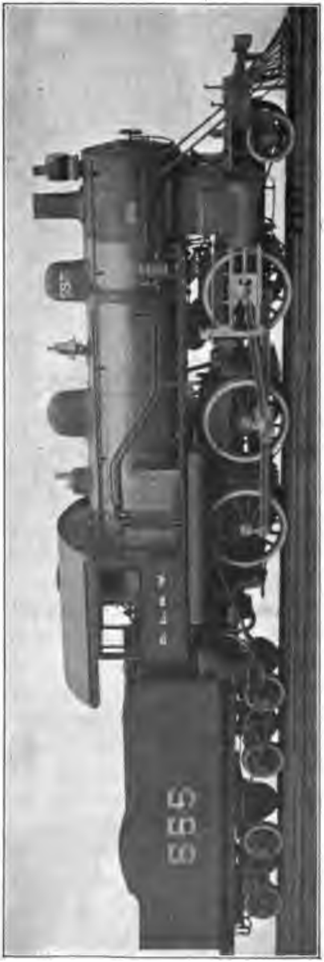
EMERGENCY.

In making an emergency application of the brakes, the K 2 triple has the same action as all other types of the standard quick-action triple valves.

CLEANING TRIPLE VALVES AND BRAKE CYLINDERS.

Q. How often should triple valves and brake cylinders be cleaned and oiled?

A. Once every ten months for freight, and once every six months for passenger.



MOGUL BUILT BY THE AMERICAN LOCOMOTIVE COMPANY.

Q. How should they be cleaned and oiled?

A. First, take the triple valve apart and immerse the removable internal metal parts in kerosene, leaving them there until the work upon the cylinder is completed; next, remove the push rod and, if a freight cylinder, put a clamp upon the piston sleeve; remove the cylinder head and piston; remove the heavy grease which is usually found in the cylinder and on the piston. After this is done, the walls of the cylinder should be well cleaned with a cloth saturated with kerosene. All rust spots should be thoroughly cleaned off, and the leakage grooves must be cleaned and freed from dirt or lint. A thorough cleaning of the expander ring packing leather and piston is also necessary. In greasing the cylinder, special attention should be given to the thorough lubrication of the top of the cylinder and the inside of the packing leather where the expander ring rests. A light grease or air-brake compound should be used for the cylinder. If too much grease is used, it will work back into the triple valve and ruin the rubber-seated valve and the gasket. See that the follower nuts are tight. After piston is entered, it can be ascertained if the expander ring has worked out of its position, by moving the end of the piston to describe a circle of about 8 inches diameter. In case the ring is out of place, this can not be done, as the piston will stick. When the piston is in its place see that the expander ring opening in one quarter turn away from leakage groove. After the cylinder head has been replaced, all bolts and nuts between cylinder and reservoir must be properly tightened. The bolts which support the cylinder should always be examined and tightened if loose; if they are loose, the movement of the cylinder, when the brakes are applied, will cause leaks in the pipe joints. In cleaning the triple valve, special care should be given to the slide valve, the graduating valve, the slide valve seat, the packing rings of the triple valve piston, and the emergency rubber-seated valve. In order to avoid springing the triple-valve piston packing ring, it should never be removed except for the purpose of renewal. After the triple valve has been thoroughly cleaned of all dirt and lint, it should be oiled. Seven or eight drops of oil are sufficient for lubricating the entire triple valve, as none should be used on the quick-acting parts. The slide valve, its seat, the triple-valve piston packing rings and the bushing in which it works should be properly lubricated. Care should be taken not to permit any oil to get upon the gaskets or rubber-seated valve. After the triple valve is put together and back in place, the train pipe and auxiliary reservoir should be charged with air, and all pipe joints tested, with soap suds or a lighted torch, for leaks.

DEFECTS OF THE AUXILIARY RESERVOIR BRAKE CYLINDER AND THEIR CONNECTIONS ON CARS.

Q. If the auxiliary reservoir fails to charge, where is the trouble?

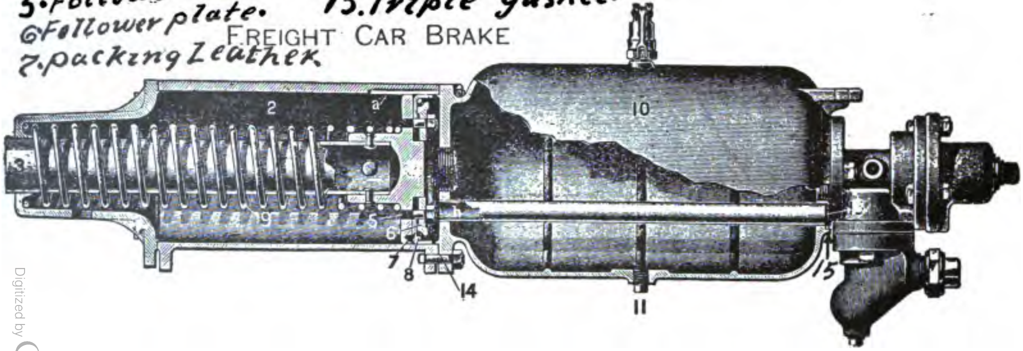
A. Strainer in drain cup where crossover pipe connects to train pipe partially or wholly stopped up, or strainer in triple valve stopped up, or a leak in auxiliary reservoir, feed port i k in triple valve stopped up.

Q. If the brake fails to apply after auxiliary has charged, what is the trouble?

A. Strainer in drain cup or triple valve partially stopped up, or leaky piston packing rings on piston No. 5 in triple valve, or a sticky triple valve piston. If the brake fails to apply with a 7 or 8-pound train line reduction keep reducing the train-line pressure until a 20-pound reduction has been made. A sticky triple valve piston will usually let go with a 20-pound reduction and the brake will apply in emergency.

Details,
a·Leakage groove.
3·Sleeve.
5·Follower Stud.
6·Follower plate.
7·packing Leather

8·Expander Ring.
9·Release spring.
14·Cylinder gasket.
15·Triple gasket.



FREIGHT CAR BRAKE

Q. If the brake fails to release after the train-line pressure has been increased above that of the auxiliary reservoir, where is the trouble?

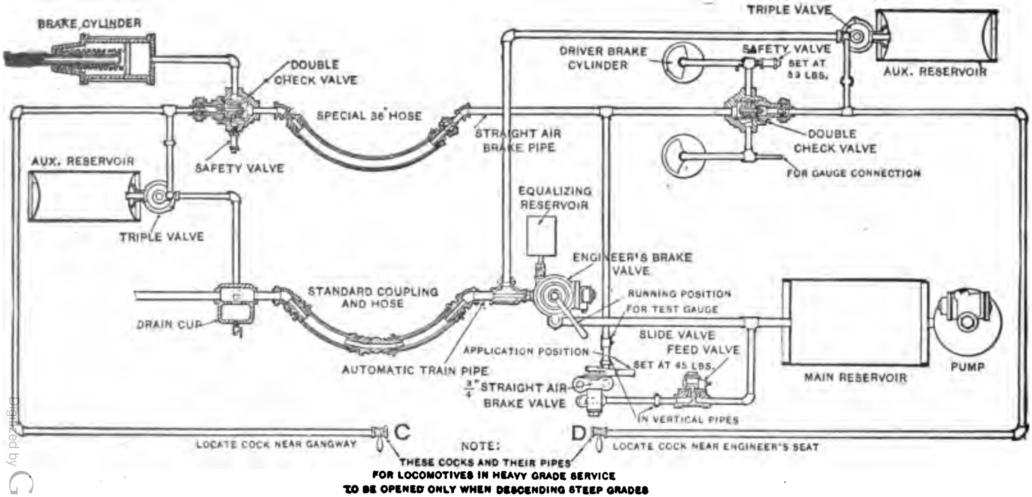
A. One of the strainers is partially stopped up or a leaky triple valve piston packing ring on piston No. 5, or a sticky piston No. 5.

Q. If the brake releases immediately after it has been applied with a 7 or 8-pound train-line reduction, where is the trouble?

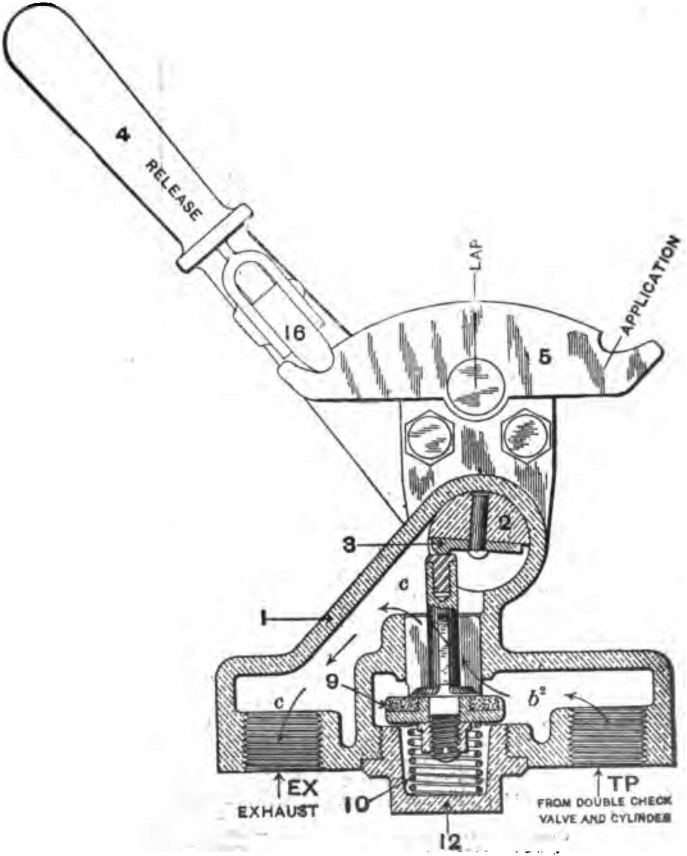
A. A leaky graduating valve No. 7, or a leaky slide valve No. 3, a leaky triple valve gasket No. 15, auxiliary reservoir pipe leaking, or a leak from auxiliary reservoir to the atmosphere. If the brake releases after it has been applied with a 20-pound reduction, it is due to a leaky slide valve 3 or a leak from auxiliary reservoir. A leaky packing leather in brake cylinder will cause brake to release or a leaky brake cylinder gasket No. 14, but air will not blow through the triple valve exhaust when brake is releasing.

THE COMBINED AUTOMATIC AND STRAIGHT AIR BRAKE.

The combined automatic and straight-air engine and tender brake consists of the standard automatic arrangement employed on engine and tender with the addition of a straight-air brake valve and a few simple parts which permits of the use of straight-air on engine and tender brake without interfering with their automatic action when the automatic brake valve is used, both being kept cut in at all times. The many and important advantages of an independent engine and tender brake are obtained, while preserving at all times every function of the automatic on those and the train brakes. Without this latter requisite no independent brake can be considered safe or economical. The straight-air is for switching freight and passenger locomotives.



COMBINED EQUIPMENT.



CROSS SECTION OF STRAIGHT-AIR BRAKE VALVE

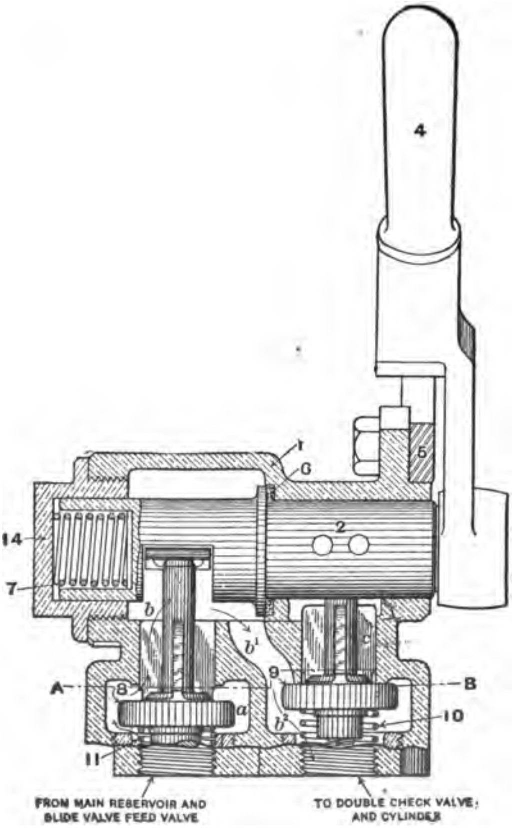

4
5
1
G
2
14
7
b
b¹
c
9
A
8
a
B
10
b²
11
FROM MAIN RESERVOIR AND SLIDE VALVE FEED VALVE
TO DOUBLE CHECK VALVE AND CYLINDER

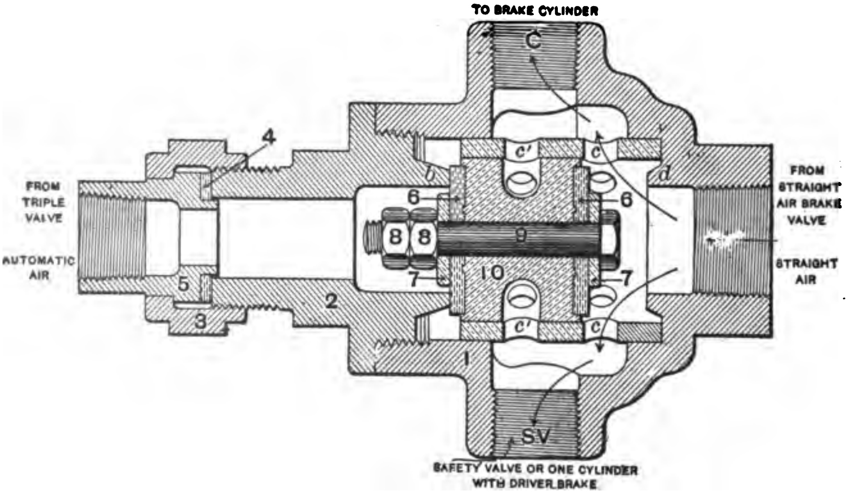
FIG. 9—STRAIGHT-AIR BRAKE VALVE

COMBINED EQUIPMENT.

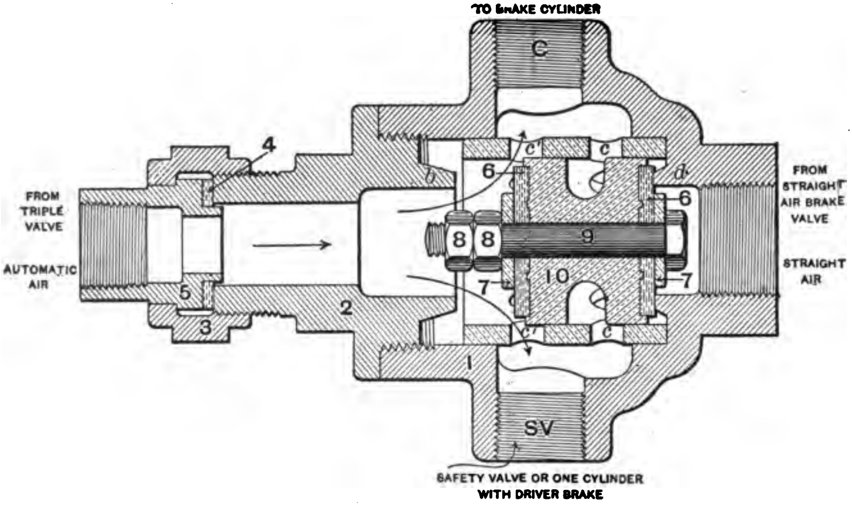
Aside from the pipes, special hose and cocks C and D the straight-air brake apparatus consists of reducing valve which is a standard slide feed valve, as used on the automatic brake valve, set at 45 pounds. An engineers straight-air brake valve having three positions release lap and application two double check valves and two safety valves, set at 53 pounds. The cocks C and D with their pipes are only for locomotives operating on heavy mountain grades. The hose connection between tender and engine differs from the automatic, a wrong coupling can not be made. The union end being forward permits cutting out of the tender straight-air brake if from any cause it becomes inoperative, by inserting a blind gasket in the union.

STRAIGHT AIR BRAKE VALVE.

Practically the only renewals required for this valve are the two leather seats and washer. The renewal of these parts are easily effected. The spring beneath the application and release valves 8 and 9 tend to move the handle toward lap if it is in either application or release position, Notches are provided to guard against this, and it must be seen that wear or weakening of the handle spring will not permit the handle to work away from three positions. This is particularly important with the release position, in which the jarring of the engine in motion aids the spring below the release valve. If the handle were to work up so the release valve could close an automatic application and release might be followed by the driver and tender brakes sticking. Leakage at application valve 8, figure 9, will cause the brakes to creep on when the handle is on lap, and a steady blow at the exhaust when the



Double Check Valve in Straight-Air Brake Position



Double Check Valve in the Automatic Brake Position handle is in release position. A leak past release valve 9 or washer 6, figure 9, will cause a steady blow at the brake valve exhaust when the straight-air is applied.

The double check valve must be placed in a horizontal position so that its piston valve will not be moved except by air pressure, then the mere act of using either automatic or straight-air will cause its piston valve to move automatically to the proper position.

The double check valve can leak at either of its two seats. If there is no blow at either of the triple valve exhaust ports, when the brakes are off, but occurs at one when the straight-air is applied, the double check valve leather seat toward the triple valve connection is defective. The opposite seat being in bad order will cause a blow at the exhaust port of the straight-air valve with automatic set and none with brakes released.

BRAKE CYLINDER LEAKAGE.

Any leakage in the pipes from the straight-air brake valve to the cylinders, or in the latter, will be indicated as follows: with pressure fully pumped up, note the pump strokes per minute required to maintain it; then place the straight-air valve in full application position, wait until main reservoir pressure is fully restored and again count the pump strokes per minute. The difference will be due to leakage somewhere.

With the straight-air brake valve in application, position of any leakage can readily be found, as it is constantly supplied with air. Piston travel can be accurately determined at the same time.

CLEANING AND OILING.

In cleaning and oiling the straight-air brake valve, all parts should be wiped clean, and the application and release valves replaced without oil; a little heavy oil or brake-cylinder grease, however, can be used to good advantage on the main shaft and its gasket. The slide valve reducing valve should be thoroughly cleaned and a small amount of valve oil used on its piston and slide valve. The double check valves and safety valves should be cleaned, but no oil required.

INSTRUCTIONS FOR OPERATING.

1. Always keep both brakes cut in and ready for operation, unless failure of some part requires the cutting out of one or the other.

2. Always carry an excess pressure of 10 pounds or more in main reservoir, as it is necessary to insure uniformly satisfactory operation.

3. When using automatic, keep the straight-air brake valve in release position; and when using straight-air, keep the automatic brake valve in running position; this is to avoid sticking of driver and tender brakes.

4. Excepting in emergencies, automatic must not be used on a train while straight air is applied on the engine and tender; if automatic is wanted, first release the straight-air.

5. Though the use of straight-air while automatic is applied will not increase the driver and tender brake cylinder pressure above 45 pounds, yet the release of either can not be assured while the other brake valve is on lap or application position.

6. . Bear in mind that the straight-air on the driver and tender brakes is almost as powerful as the automatic brakes on same, that each should be used with care to avoid rough handling of train or in holding down a long grade loosening of tires on drivers. When the straight-air is used to aid in recharging trains in motion down

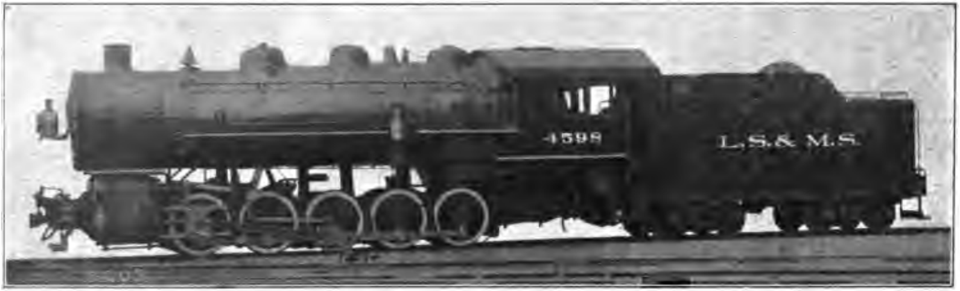
steep grades, the automatic should be kept inoperative by having cocks C and D open.

7. The straight-air reducing valve should be kept adjusted at 45 pounds, and the driver and tender safety valve 53 pounds. Where a full application of the straight-air causes either or both safety valves to operate, it indicates too high adjustment of the reducing valve, too low adjustment of safety valves, or leakage at the latter, have them tested and adjusted.

8. To release train brakes at low speed, apply the straight-air either immediately before or after moving the automatic brake valve to release position, and maintain a strong straight-air holding power until all train brakes are released; then if no stop is to be made, gradually release the straight-air, after which use steam carefully, if needed, until the train slack is all out.

9. In using the straight-air to slow a train from ordinary speed, to stop it from same on an ascending grade, or on the level at slow speed, gradually run the slack in or out, according to the direction of movement, remembering that the slower the speed the more holding power the same cylinder pressure will give, because of the greater shoe friction at slow speeds. For the same reason, partially release the straight-air just before stopping, so as to relieve the coupling spring tension and reduce the liability of wheel sliding. If on an ascending grade, fully release the straight-air as soon as the stop is made, reapplying lightly after the train starts back, in case this occurs.

10. For quick work and economy in air, as with automatic, keep the piston travel well maintained and avoid cylinder leakage. Piston travel increases more rapidly with straight-air, because of greater use, than with automatic alone, and requires more frequent adjustment. When



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doing short switching with an engine having brake cylinders with long piston travel, or when making applications in rapid succession, to release, lower the air pressure only until the brakes do not hold; this will economize air and hasten the following application; but be sure to keep the straight-air valve brake in the release position at other times when holding power is not wanted.

11. To hold a standing train on a grade, if ascending, take the slack out with steam, then apply the straight-air; if descending, and cocks C and D are open, run the slack in with straight-air just as the stop is being completed; or, if already stopped, reverse, move the automatic brake valve handle to release and at once shove in all slack by full use of steam; then apply the straight-air and shut off steam. Keep the automatic brake recharged when holding with straight-air, this being the main object sought. In holding with straight-air, leave its brake valve in full application position. This is assuming that the reducing and safety valves are correctly adjusted, and that there is no serious cylinder leakage to waste air.

12. If a burst hose or other automatic application causes driving wheels to slide, release their brake at once, where the provision is made by opening the cut-out cock D.

13. The use of straight-air to aid in recharging the train brakes when descending a heavy mountain grade, open the cut-out cocks C and D on passing the summit. This will prevent the automatic from acting on the drivers and tender brakes, but their auxiliary reservoirs will be recharged with those of the train. The straight-air may then be used irrespective of the automatic, the only restriction being to avoid rough handling or overheating of driver tires; if cocks C and D should not be opened and the straight-air and automatic used alternately down heavy

grades, drivers and tender wheels would be overheated. The straight-air should be used not only to aid in hilding the train while recharging its brakes, but also to avoid a possible jerk from slack running out when the speed is brought very low just before recharging.

14. To insure against the engine moving when oiling, taking water, or standing on turn-table, or when leaving it for a time, let the straight-air valve remain in application position.

TESTING THE BRAKES.

Q. How should the brakes be tested before leaving a terminal point, and after each change in the make up of the train, and before starting to descend a long, heavy grade?

A. When the engine is coupled to train, and the required pressure is equalized throughout the train, the engineman, upon the request of a trainman, will make a full service application of the brakes (20 pounds reduction of pressure), and hold them on until the trainmen have examined the brakes on the tender and on each car. If the trainmen find the brakes in proper condition, they shall signal from the rear end of the train to the engineman, who will release the brakes. The trainmen will examine the brakes on each car and tender to know that they released properly, after which they must report to the engineman the number of cars in train, number of cars on which the brakes are in proper working order, and tonnage of train.

PISTON TRAVEL.

Q. What is standing travel?

A. The distance the piston is forced outward in applying the brake upon a car when not in motion.

Q. What is running travel?

A. The distance the piston is forced out in applying the brake upon a car when in motion. The running travel is always greater than the standing travel, the increase being due to slack in loose-fitting brasses, to shoes pulling down upon the wheels, to play between boxes and pedestals, and to everything of similar nature that increases lost motion in the brake rigging under the influence of the motion of the car.

Q. What should the running travel be on all tenders, freight and passenger cars?

A. Eight inches. In order to get this, the standing travel should be adjusted to 6 inches.

Q. How far should the driver brake piston travel when applying the brake?

A. Not less than one-third or more than two-thirds of the full stroke of the piston.

Q. What effect will the piston travel that varies throughout the train have on the braking on that train?

A. A sufficient train-pipe reduction must be made to fully apply the brakes having the longest piston travel; in releasing, the increasing train-pipe pressure will force the triple valve piston on the car with an 11-inch piston travel to release position first, the one on the car with a 10-inch travel next, and so on down, those with the shortest travel being applied with the greatest force and relasing last. The satisfactory operation of the brake can only be secured by uniformity of piston travel upon all cars in a train. If the piston travel be unnecessarily long, the brake-cylinder pressure is thereby reduced, and the efficiency of the brakes impaired; in addition, a greater quantity of compressed air is used in brake applications than would otherwise be necessary, thereby entailing greater demand upon the air pump, which will increase the wear on the pump. If the piston travel is too short, it is apt to cause the brake shoes to drag upon the wheels when the brakes are released, and when applied they are liable to slide the wheels, caused by too high a brake-cylinder pressure.

ADJUSTING PISTON TRAVEL.

Q. When must the piston travel be adjusted on engine and tender, freight and passenger cars?

A. On tender and freight cars when the piston travel exceeds 9 inches; on passenger cars when the travel exceeds 8 inches; on drivers when the piston travel is found to be more than two-thirds of their stroke.

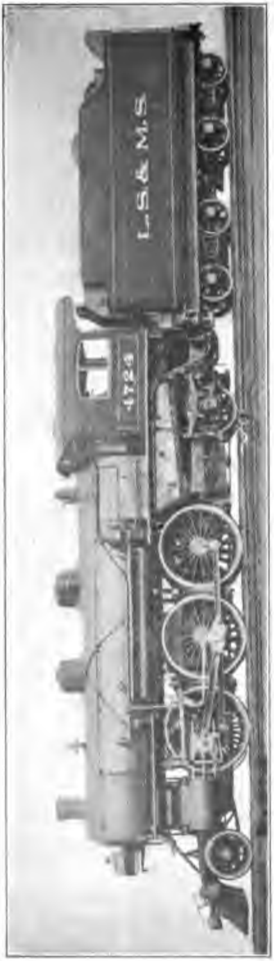
Q. How is the slack taken up so as to secure the adjustment of tender, freight and passenger cars?

A. By means of the dead truck lever, and if that is not sufficient, one or more holes must be taken up in the underneath connection, and the adjustment then made by the dead truck lever. In taking up the slack, it must be first ascertained that the hand brakes are off and the slack is all taken out of the upper connections, so that the truck levers do not go back within one inch of the truck timber or other stop, when the piston of the brake cylinder is fully back at the release position.

Q. What are the different holes in the outer end of some of the cylinder levers for, and why must the connections be pinned to the proper hole for each car?

A. Those holes are to enable the adjustment of the brake pressure to be made according to the weight of different cars. The connection must be made to the proper hole in each case, according to the weight of the car, so as to give proper braking power, otherwise the brake will be inefficient or the wheels may be slid under some cars.

Q. How can the piston travel on freight cars be tested



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and then taken up the proper length when cars are not charged with air and brakes operated?

A. See that the push rod going from piston to brake cylinder lever is clear in against the bottom of piston sleeve. Make a mark on the push rod even with the end of sleeve. Set the brake by hand as tight as possible, with a club if necessary; the distance push rod is pulled out of sleeve is the piston travel. When testing with air, make a full service application of 20 pounds, so as to get full piston travel.

Q. How are the driver brake piston travel adjusted?

A. The American equalized driver brake is adjusted by means of set screws. The equalized driver brake of the Pennsylvania Railroad and some other roads are adjusted by means of a turnbuckle. Some of the pull up driver brakes are adjusted by screwing the piston rod into the piston rod extension. The cam driver brake is adjusted by means of the cam screws. In adjusting the cam brake care must be taken to adjust both cams alike, so that the point of contact of the cams shall be in line with the piston rod.

HIGH-SPEED BRAKE.

Q. What changes are necessary to transform the automatic brake into a high-speed brake, on an engine?

A. In the first place, the engine-truck wheels are supplied with brakes as well as the drivers. The engine is provided with a special plain triple valve that operates both driver and engine-truck brakes; the engine-truck brake cylinder is connected with a flexible hose connection to its branch pipe; an automatic reducing valve is connected to the pipe that leads from the triple valve to the brake cylinders; the plain triple valve on the tender is replaced by a quick-action triple valve; there is an automatic reducing valve connected to the tender brake cylinder; the ordinary form of pump governor is replaced by a duplex governor, and the feed-valve attachment on the brake valve is replaced with a pipe bracket that enables a duplex feed-valve attachment to be used. The duplex governor and duplex feed valve consist of two ordinary instruments combined for convenience, one of the governors being adjusted at 90 pounds and the other one at about 120 pounds pressure. The two feed valves of the duplex feed-valve attachment are adjusted for different pressures: one is set for 70 pounds and the other one for 110 pounds. There is a cut-out catch placed in the pipe to low-pressure governor; there is a reversing cock placed between the two feed valves; the reversing cock is so constructed that the low-pressure feed valve can be cut out of or into service by means of the handle. When the low-pressure governor and feed valve are in control of the main-reservoir and train-pipe pressures, the engine is ready to handle the ordinary quick-acting brake. All that is necessary to change to have the engine ready for high-speed brake is to turn the handle of the cut-out cock to low-pressure governor, and the reversing cock between the feed valves so that the high-pressure governor and feed valve will control the main reservoir and train pipe.

Q. What change is necessary in car equipment?

A. Passenger car that is equipped with the Hic quick-action brake, the only thing necessary, if every wheel on the car is fitted with brake, is to connect an automatic reducing valve to the brake cylinder. As the functions of all parts of the brake apparatus with the high-speed brake are the same as with the quick-action brake, they are subject to the same defects and troubles.

E. T. LOCOMOTIVE EQUIPMENT.

Parts of the equipment, aside from the air pump, main reservoir and piping and brake cylinders are:

1. A duplex pump governor to control the pump when the pressures are attained for which it is regulated.
2. A distributing valve and small double-chamber-reservoir to which it is attached, placed on the locomotive to perform the functions of triple valves, auxiliary reservoirs, double check valve, high speed reducing valve, etc.
3. Two brake valves, the automatic to operate locomotive and train brakes and the independent to operate locomotive brakes only.
4. A feed valve to regulate the train pipe pressure.
5. A reducing valve to reduce the pressure for the independent brake valve and for the air signal system when used.
6. Two air gauges; one a duplex to indicate brake pipe-pressure and main reservoir pressure; the other a single pointer to indicate locomotive brake cylinder pressure.

The pipe connections are as follows:

Reservoir pipe; connects the main reservoir to the automatic brake valve, distributing valve, feed valve and reducing valve.

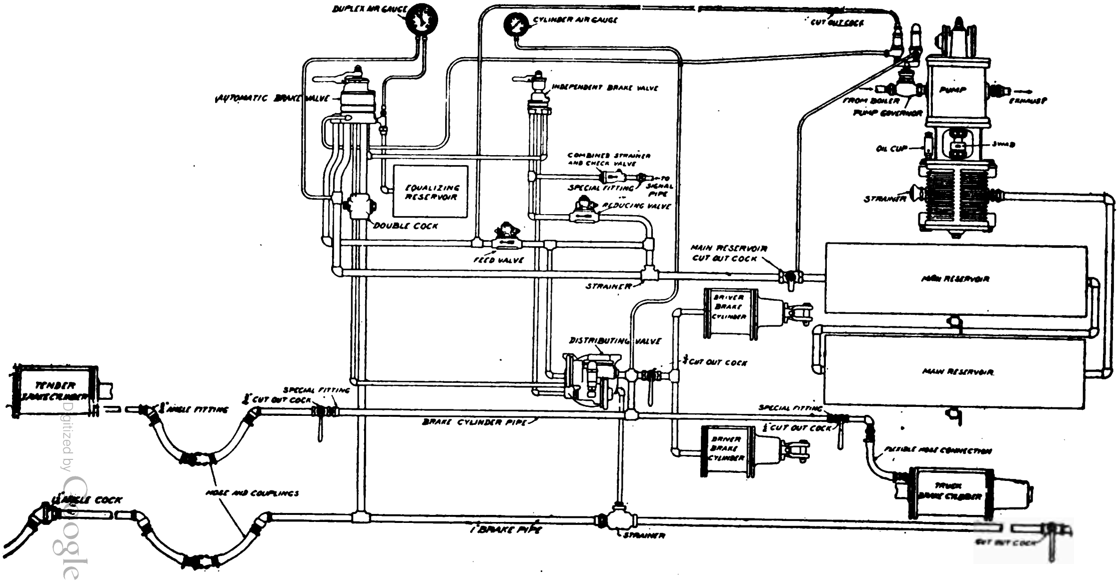
Feed valve pipe; connects the reducing valve to the independent brake valve and signal system when used.

Brake pipe; connects the automatic brake valve with the distributing valve and all triple valves on the train.

Brake cylinder pipe; connects the distributing valve with the driver, tender and truck cylinders.

Application-chamber pipe; connects the application chamber of the distributing valve to the automatic brake valve through the independent brake valve.

Double-heading pipe; connects the application chamber



PIPING DIAGRAM OF THE ET EQUIPMENT

exhaust port of the distributing valve to the automatic brake valve through the double cut out cock.

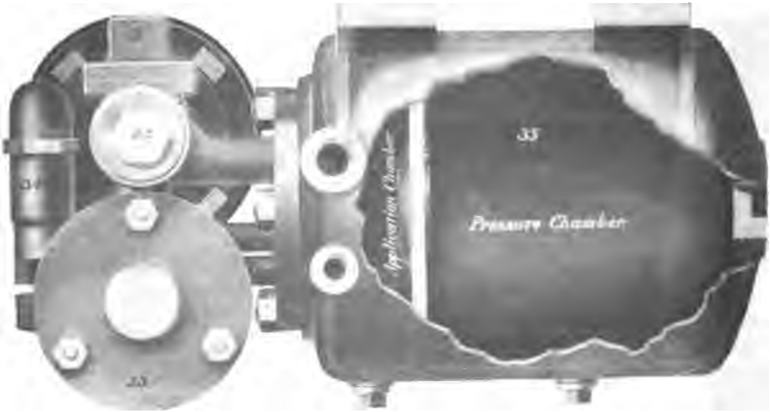
ARRANGEMENT OF THE APPARATUS.

Air compressed by the pump passes, as usual, to the main reservoir and the reservoir pipe. The main reservoir cut-out cock is to cut off the supply of air when removing any of the apparatus, except the governor. The end toward the main reservoir is tapped for a connection to the maximum pressure head of the pump governor. When closed it discharges the air from the pipe between it and the automatic brake valve. Beyond the main reservoir cut-out cock the reservoir pipe has four branches, one of which runs to the automatic brake valve, one to the feed valve, one to the reducing valve and one to the distributing valve. As a result the automatic brake valve receives air from the main reservoir two ways, one direct and the other through the feed valve.

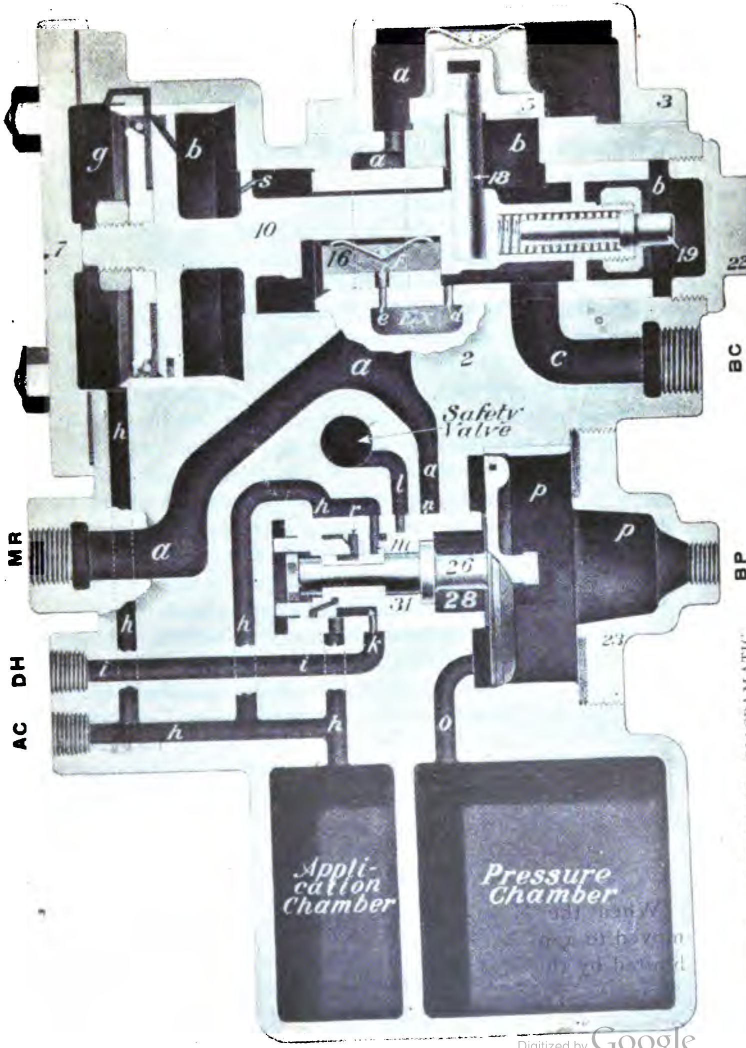
The feed-valve pipe from the feed valve to the automatic brake valve has a branch to the top of the excess-pressure head of the duplex pump governor.

The third branch of the reservoir pipe connects with the reducing valve. Air at the pressure for which this valve is set, 45 pounds, is thus supplied to the independent brake valve through the reducing valve pipe. When the signal system is used it is connected to the reducing valve pipe, in which case the reducing valve takes the place of the air signal reducing valve.

The distributing valve has five pipe connections made through the double-chamber reservoir, three on the left and two on the right. Of the three on the left the upper is the supply from the main reservoir; the intermediate is the double-heading pipe, leading through the double cut-out cock, when turned to cut out the brake valve from the brake pipe to the automatic brake valve; and the lower is the application-chamber pipe leading through the independent-brake valve, when the handle is in running position, to the automatic brake valve. Of the two on the right, the lower is the brake-pipe-branch connection, and the upper is the brake-cylinder pipe branching to all brake cylinders on the engine and tender. In the pipe are placed cocks for cutting out the brake cylinders when necessary, and in the engine and tender brake cylinder cut-out cocks are placed, special choke fitting to prevent serious loss of main reservoir air and the release of other locomotive brakes during a stop, in case of a burst brake cylinder hose connection. The cylinder gauge is connected with the brake cylinder pipe.



DISTRIBUTING VALVE AND DOUBLE CHAMBER RESERVOIR.



THE DISTRIBUTING VALVE, DIAGRAMATIC.

The automatic-brake-valve pipe connections, other than already mentioned, are the brake-pipe branch through the double cut-out cock, the main reservoir, the equalizing reservoir, the duplex gauge and the lower connection to the excess-pressure head of the pump governor.

Pipe connections. M. R., main-reservoir pipe; D. H., double-heading pipe; A. C., application-chamber pipe; B. C., brake-cylinder pipe; B. P., brake pipe.

To simplify the tracing of the ports and connections, this valve is illustrated diagramatic; that is, the valve is distorted to show the parts differently than actually constructed with the object of explaining the operation clearly instead of showing exactly how they are designed. The chambers of the reservoir are for convenience indicated at the bottom as a portion of the valve itself. The diagramatic illustration shows each slide valve in two parts, one below and the other above the piston stem, with similar division of parts in the bush. Referring to the figure, it will be seen that main reservoir pressure is always present in the chamber surrounding application valve 5 by its connection through passage A. A. to the main reservoir pipe. Chamber B to the right of application piston 10 are always in free communication with the brake cylinder through passage C and brake-cylinder pipe. Chamber G at the left of application piston 10 is a portion of the application chamber, being always connected with it by passage H, and is also connected to the brake valve through the application-chamber pipe.

INDEPENDENT APPLICATION.

When the handle of the independent brake valve is moved to application position, air from the main reservoir, limited by the reducing valve to a maximum of 45 pounds, is allowed to flow to the application chamber, forcing application piston 10 to the right. We will assume that 45 pounds is so admitted and maintained. This movement of application piston 10 causes exhaust valve 16 to close exhaust ports E and D, and the graduating stem 19 to compress its spring; also open application valve 5 by its connection with the piston stem by pin 18, main reservoir air then flows through port B and passage C to the brake cylinders until there pressure and that in chamber B equals the application-chamber pressure, in this case 45 pounds. The graduating spring then forces the application piston 10 to the left until application valve 5 closes port B, but without moving exhaust valve 16. This position is known as independent lap.

From the above description it will be seen that application piston 10 has application-chamber presure on one side and brake cylinder pressure on the other. When either pressure varies the piston will move toward the lower, consequently if that in chamber B is reduced by brake-cylinder leakage, the pressure maintained in the application chamber will force piston 10 to the right, opening application valve 5 and again admitting main reservoir air to the brake cylinder until the pressure on both sides of piston 10 are again equal, when the graduating spring will force the piston brake to lap position. In this way the brake-cylinder pressure is always maintained to that in application chamber; this is called the pressure maintaining feature.

INDEPENDENT RELEASE.

When the handle of the independent brake valve is moved to release position, a direct opening is made through the rotary valve from the application chamber to the atmosphere. This permits the pressure in the application chamber to escape, therefore, as this pressure is being exhausted, brake-cylinder pressure in chamber B moves application piston 10 to the left causing exhaust valve 16 to open exhaust port E and D, thereby allowing brake-cylinder pressure to escape to the atmosphere. If the independent brake valve is returned to lap before all of the application-chamber pressure has escaped, the application piston 10 will return to independent lap position as soon as the brake-cylinder pressure is reduced to a little below that remaining in the application chamber.

AUTOMATIC.

During the automatic operation of the brake, the lower movable parts, known as the equalizing parts, are brought into action. Automatic release.—Referring to the cut, which shows the movable parts of the valve in release position, it will be seen that as chamber P is connected to the brake pipe, brake-pipe air flows through the groove around the top of piston 26 into the chamber above the slide valve 31 and through port O to the pressure chamber until the pressure on both sides of the piston is equal.

SERVICE APPLICATION.

When a service application is made with the automatic brake valve, the brake pipe pressure in chamber P is reduced, causing a difference in pressure on the two sides of the piston, which results in the piston moving toward the right. The first movement of the piston closes the feed groove and at the same time moves the graduating valve until it uncovers the upper end of port Z in the equalizing slide valve 31. As the piston continues its movement the shoulder on the end of its stem engages the slide valve which is then also moved to the right until port Z in the slide valve registers with port H in the seat. As the slide valve chamber is always in communication with the pressure chamber, air can now flow from it to the application chamber; this pressure forces application piston 10 to the right, causing application valve 5 to uncover port B and allow main reservoir air to flow to the brake cylinder through port C, as in air independent application. During the movement just described, cavity T in the graduating valve connects ports R and S in the equalizing slide valve and by the same movement ports R and S are brought into register with ports H and L in the seat, thus establishing a communication from the application chamber to the safety-valve, which being set at 53 pounds, limits the brake-cylinder pressure to this amount during a full service application. The amount of pressure resulting in the application chamber for a certain brake pipe reduction depends on the comparative volumes of the application and pressure chambers. Those volumes are such that with 70 pounds in the pressure chamber and nothing in the application chamber, if they are allowed to remain connected by the ports in the slide valve, they will equalize at about 50 pounds.

SERVICE LAP.

This condition just described continues until the pressure in the pressure chamber is reduced enough below that in the brake pipe to cause the difference in pressure on the two sides of piston 26 to force it and graduating valve 28 to the left until the shoulder on the piston stem strikes the right hand end of slide valve 31; in this position graduating valve 28 has closed port Z so that no more air can flow from the pressure chamber to the application chamber, and it also has closed port S, cutting off communication to the safety valve. The flow of air past application valve 5 to the brake cylinder continues until their pressure equals that in the application chamber when the graduating spring forces piston 10 to A position, closing port B. The brake-cylinder pressure is then practically the same as that in the application chamber. It will be seen that whatever pressure exists in the application chamber will be maintained in the brake cylinder by the pressure maintaining feature already described. When the automatic brake valve is placed in release position, and the brake pipe pressure in chamber P is increased above that in pressure chamber, equalizing piston 26 moves to the left, carrying with it equalizing slide valve 31 and graduating valve 28 to the release position; the feed groove now being open permits the pressure in the pressure chamber to equalize with that in the brake pipe as before described. This action does not release the locomotive brake, because it does not discharge application chamber pressure. The double-heading pipe is closed at the double cut-out cock, and the application chamber pipe is closed by the rotary valve of the automatic brake valve; therefore, to release the locomotive brakes the automatic brake valve must be moved to running position, or the independent brake valve must be held in release position, in which positions the rotary valves of either will connect the application chamber pipe with the atmosphere. As the application chamber pressure escapes, the cylinder pressure will force application piston 10 to the left until exhaust valve 16 uncovers exhaust ports D and E, allowing brake-cylinder pressure to escape.

EMERGENCY.

When a sudden and heavy brake-pipe reduction is made, as in an emergency application, the pressure in the pressure chamber forces application piston 26 to the right until it strikes against the leather gasket beneath head 23; this movement causes slide valve 31 to uncover port H in the bush, making a large opening from the pressure chamber to the application chamber, so that they quickly become equalized. In the emergency position of the automatic brake valve the volume of the equalizing reservoir is connected to that of the application chamber. This reservoir volume, together with that of the pressure chamber at 70 pounds pressure, equalizes into the application chamber at about 60 pounds. The dotted port M in the slide valve registers with port N in the seat, connecting with supply passage A, allowing air from main reservoir to enter the slide valve and application chamber. A cavity in the slide valve registers with port H in the seat; port R in the slide valve registers with Z, leading to the safety valve. The cavity and port R in the slide valve are connected by a small port, the size of which permits the air in the application chamber to escape a little faster than port M and N can supply it, preenting the pressure from raising above the amount desired.

HIGH-SPEED.

In the high-speed brake service the feed valve is regulated for 110 pounds brake-pipe pressure, instead of 70, and main reservoir pressure is 130 or 140 pounds. Under these conditions an emergency application raises the application chamber pressure to about 85 pounds, but the area of the small passage to port A is so proportioned that the flow of application chamber pressure to the safety valve is just enough greater than the supply through M to decrease that pressure in practically the same time and manner as is done by the high-speed reducing valve until it is approximately 60 pounds. The application portions operate similarly to but more quickly than in the service application.

EMERGENCY LAP.

The above condition continues until the brake cylinder pressure equals the application chamber pressure, when the ports of the valve assume the position known as emergency lap. The release after emergency is the same as that following service application.

DOUBLE HEADING.

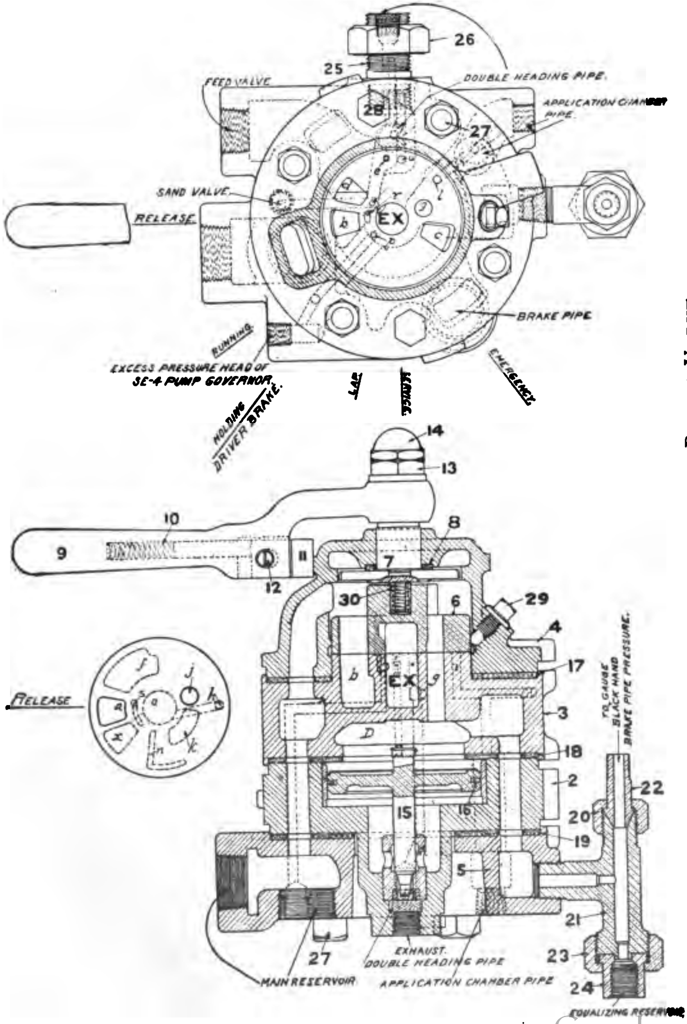
The double heading pipe connection is only used when the engine does not control the train brakes, and it then becomes an exhaust opening for the distributing valve when the automatic brake valve is on lap and cut off from the brake pipe by the double cut-out cock. To remove piston 10 and slide valve 16 it is absolutely necessary to first remove cover 3, slide valve 5 and valve pin 18.

THE TYPE H AUTOMATIC BRAKE VALVE.

This brake valve, although modeled to a considerable extent upon the principles of the previous valves, is necessarily different in detail, since it not only performs all the functions of such types, but also those absolutely necessary to obtain all the desirable operation features of the distributing valve.

RUNNING POSITION.

This is the proper position of the handle to release the engine and tender brakes; also when the brakes are not being used and the system is charged and ready for an application. In this position cavity F in the rotary valve connects ports B and D in the valve seat, affording a large direct passage from the feed valve to the brake pipe, so that the latter will charge up as rapidly as the feed valve can supply the air, but can not attain a pressure above that for which the feed valve is adjusted. Cavity K in the rotary valve connects C and G in the valve seat, so that



TYPE H AUTOMATIC BRAKE VALVE.

chamber D and the equalizing reservoir charge uniformly with the brake pipe, keeping the pressure on the two sides of the equalizing piston 15 equal. Port S in the rotary valve registers with port P in the valve seat, permitting main reservoir pressure, which is present at all times above the rotary valve, to pass to the excess-pressure head of the pump governor. Port H in the rotary valve registers with port L in the seat, connecting the application-chamber pipe to the exhaust cavity E X.

SERVICE POSITION.

This position gives a gradual reduction of brake-pipe pressure to cause a service application. Port H in the rotary valve registers with port S in the seat, allowing air from chamber D and equalizing reservoir to escape to the atmosphere through cavities O in the rotary valve and E X in the valve seat. Port E is restricted so as to make the pressure in the equalizing reservoir and chamber D fall gradually. As all other ports are closed, the fall of pressure in chamber D allows the brake pipe pressure under the equalizing piston 15 to raise it and unseat the discharge valve, allowing brake-pipe air to flow to the atmosphere when the pressure in chamber D is reduced the desired amount, the handle is moved to the lap position, thus stopping any further reduction in that chamber. Air will continue to discharge from the brake-pipe until its pressure has fallen to an amount a trifle less than that retained in chamber D, permitting the pressure in this chamber to force the piston 15 downward and stop the discharge of brake pipe air. It will be seen, therefore, that the amount of reduction in the equalizing reservoir determines that in the brake pipe regardless of the length of the train.

LAP POSITION.

This position is used while holding the brakes applied after a service application until it is desired either to make a further brake pipe reduction, or to release them; also to prevent loss of main-reservoir pressure or the release of the brake in the event of a burst hose, a break in two or the opening of the conductor's valve. Lap position is also used on all engines in a train that are not controlling the train brakes, as with the handle in this position, port H in the rotary valve connects with port U in the seat; therefore, when the double cut-out cock is turned to the position which cuts out the brake pipe, it makes a direct opening from port I in the distributing valve through the double-heading pipe to the atmosphere, and is the passage through which the air escapes from the application chamber when the automatic brakes are being released.

RELEASE POSITION.

The purpose of this position is to provide a large and direct passage from the main reservoir to the brake pipe, to permit a rapid flow of air into the latter, to insure a quick release and recharging of the train brakes, but without releasing the engine and tender brakes.

Air at main reservoir pressure flows through port A in the rotary valve to port B in the seat and to the brake pipe. At the same time port J in the rotary valve registers with the equalizing port G in the valve seat, permitting main reservoir pressure to enter chamber D above equalizing piston. In this position, port S in the rotary valve registers with warning port R in the seat, and allows a small quantity of air to escape into exhaust cavity E X, which makes sufficient noise to attract the engineer's attention to the positioin in which the valve handle is standing. If the handle is allowed to remain in this position the brake system would be charged to main reservoir pressure. To avoid this, the handle must be moved to running or holding positions. The small groove in the face of the rotary valve which connects with port S, extends to port P in the valve seat, allowing main reservoir pressure to flow to the excess pressure head of the pump governor.

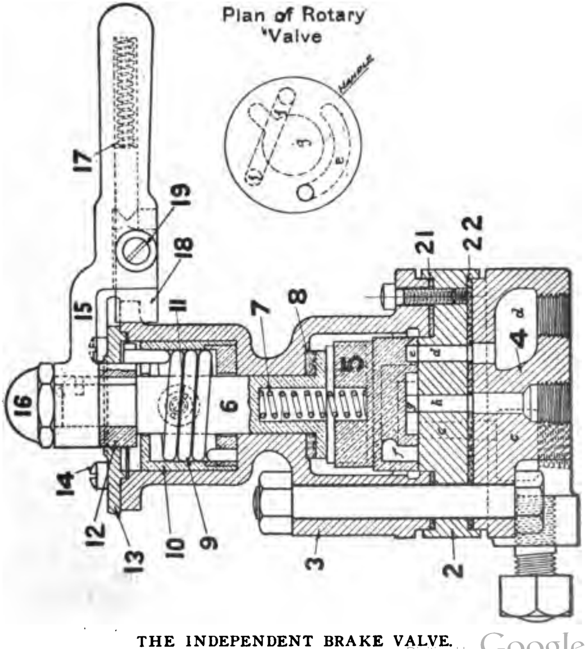
HOLDING POSITION.

This position is so named because the engine and tender brakes are held applied, as they are in release position, while the train brakes feed up to the feed valve pressure. All ports register as in running position, except port L, which is closed; therefore, the only difference between running and holding positions is that in the former the application chamber is open to the atmosphere, while in the latter it is not.

EMERGENCY POSITION.

This position is used when the most prompt and heavy application of the brakes is desired. Port X in the rotary valve registers with port C in the valve seat, making a large and direct communication between the brake pipe and atmosphere through cavity O in the rotary valve and E X in the valve seat. This direct passage causes a sudden and heavy discharge of brake pipe pressure, causing the triple valves and distributing valve to go to the emergency position and apply the brake in the shortest possible time. In this position the groove N in the rotary valve connects ports G and L in the valve seat, thereby allowing equalizing reservoir air to flow into the application chamber. The oil plug 29 is placed in to core 4 at a point to fix the level of the oil surrounding the rotary valve. Leather washer 8 prevents air in the rotary valve chamber from leaking past the rotary valve key to the atmosphere.

Spring 30 keeps the rotary valve key firmly pressed against washer 8 when no main reservoir pressure is present. The handle 9 contains a latch 11, which fits into notches in the top core, so located as to indicate the different positions of the brake valve handle. The spring 10 back of the latch forces the latter against the body with sufficient pressure to distinctly indicate when handle arrives at each position. To remove the brake valve, take off nuts 27, thus allowing it to come away without disturbing the pipe bracket or breaking any pipe joints. To take the valve proper apart, remove cap screws 28.



THE INDEPENDENT BRAKE VALVE.

THE INDEPENDENT BRAKE VALVE

This valve is of the rotary type; exhaust cavity G in the rotary valve is always in communication with exhaust groove H. Groove E in the face of the valve communicates at one end with a port through the valve. This groove is always in communication with supply port in valve seat, and through this opening air is admitted to the chamber above the rotary valve, thus keeping it on its seat. Port S in the rotary valve consists of two circular openings in the face, joined by a cylindrical passage over the top of cavity G.

RUNNING POSITION.

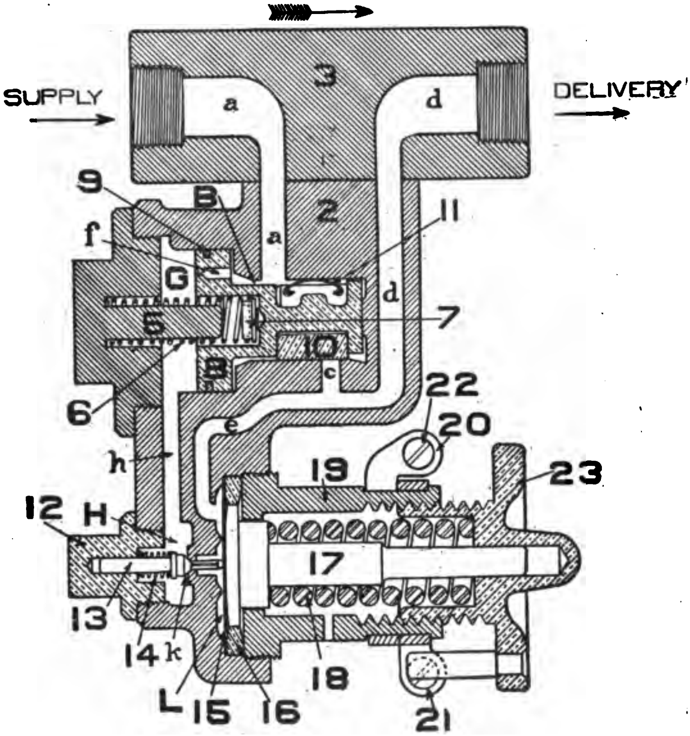
This is the position that the independent brake valve should be carried in at all times when the independent brake is not in use. Port S in the rotary valve connects ports C and D in the valve seat, thus establishing communication between the application chamber of the distributing valve and port L of the automatic brake valve; therefore, it will be seen that if the automatic brake valve is in running position, and the independent brake applied, they can be released by returning the independent valve to running position.

SERVICE POSITION.

To apply the independent brake, move brake valve handle to the application position; groove E connects the ports, allowing air to flow to the application chamber of the distributing valve. Since the supply pressure to this valve is fixed by the regulation of the reducing valve to 45 pounds, this is the maximum cylinder pressure that can be obtained.

LAP POSITION.

This position is used to hold the independent brake applied after a desired cylinder pressure is obtained, at which time all communication between operating parts are closed.



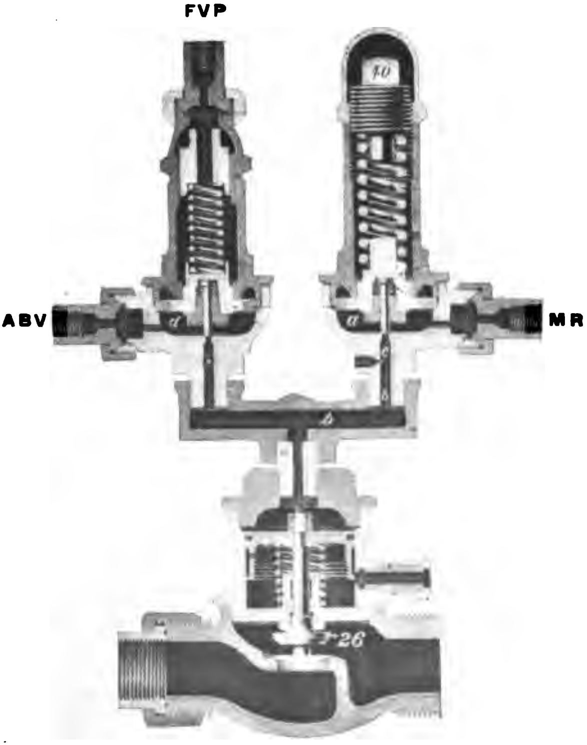
THE FEED VALVE

RELEASE POSITION.

This position is used to release the pressure from the application chamber when the automatic brake valve is not in running position. In this position the offset in cavity G registers with port D, allowing pressure in the application chamber to flow through ports D, G and H to the atmosphere. In order to prevent leaving the handle in release position, and thereby make it impossible to operate the engine and tender brakes by the automatic brake valve, spring 9 automatically returns handle 15 from release position to the running position.

THE FEED VALVE.

This valve is a slide valve feed valve of an improved type, and with this equipment is connected to a pipe bracket located in the piping between the main reservoir and the automatic brake valve, receiving its supply of air from the main-reservoir pipe and delivering it into the feed-valve pipe. It is for the purpose of controlling brake-pipe pressure when the automatic brake valve is in running or holding position. This cut is a diagramatic view of the feed valve. When the pressure in the feed-valve pipe falls below that for which it is adjusted, regulating spring 18 will force the diaphragm forward, unseat regulating valve 13 and permit the accumulated air pressure in chamber G to escape through port H, chamber H, and port K to chamber L. This allows main reservoir pressure in chamber B to force the supply valve piston 8 to the left and open port C, which again permits air to pass to the feed-valve pipe until its pressure has been restored to the proper amount. Since this feed valve has a duplex adjusting arrangement, it eliminates the necessity of the two feed valves in high and low pressure service, as the turning of handle 23 until its pin strikes stops 20 and 21



THE PUMP GOVERNOR

changes the regulation from one predetermined brake pipe pressure to another. To adjust this feed valve, slacken screws 22, which allows stops 20 and 21 to turn around spring box 19. Adjusting handle 23 should be turned until the valve closes at the lower brake-pipe pressure desired, when stop 21 should be brought in contact with the handle pin, at which point it should be securely fastened by tightening screw 22. Adjusting handle 23 should then be turned until the higher adjustment is obtained, when stop 20 is brought in contact with the handle pin and securely fastened.

THE PUMP GOVERNOR.

The air pipe connections of this governor are M R to main reservoir; A B V to the automatic brake valve; F V P to the feed valve pipe. This governor differs from the former duplex type alone in the low or excess pressure head. Air from the feed valve pipe enters at the connection F V P, and passes to the chamber above the diaphragm, adding to the pressure of regulating spring 51 in holding it down. As this spring is adjusted to a compression of about 20 pounds, the diaphragm will be held down until the main-reservoir pressure in chamber D exceeds the feed valve pipe pressure by this amount. To adjust this governor, remove the cap nut and turn adjusting nut until the compression of spring is equal to the excess of pressure desired. The port C in one of the governor heads should be plugged, to avoid an unnecessary waste of air.

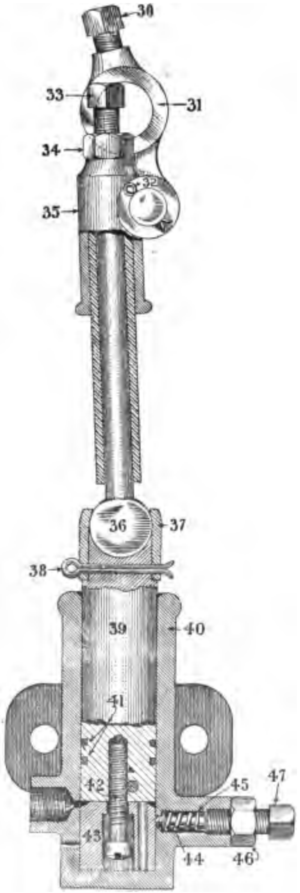
The safety valve used with this equipment is adjusted by an adjusting nut. Particular attention must be given to the holes in the valve body to see that they are open.

The instructions for handling this brake equipment are practically the same as those given for the combined automatic and straight air brake.

When not in use, carry the handles of both brake valves in running position. Remember that placing the handle of the independent brake valve in release position will release the engine and tender brakes under any and all conditions.

THE IMPROVED GOLLMAR BELL RINGER.

The Gollmar Bell Ringer No. 2 is interchangeable with the old Gollmar Bell Ringer. Its construction and its action are as follows: There are two openings in the cylinder, the upper being the inlet, tapped to receive a ⅜ pipe; the lower is the exhaust port. Pressure is admitted through the upper opening opposite chamber. The operation of valve 43, through which a 3-16 hole is drilled, admits the pressure under the single acting piston 39. Piston 39 has a stroke of 1¼ in. when at its extreme travel. Crank 31 has a stroke of 4 in. The connecting rod is in two sections, 35 and 36, which allows crank 31 to make a complete revolution without causing piston 39 to move. When the ringer is started to work, piston 39 will be driven upwards, causing the bell to swing, and valve stem 42 will raise valve 43, closing inlet port and using pressure expansively by traveling the length of the lap before it will open the exhaust port. The bell, having received an impulse, will continue its motion after the piston 39 has reached the upper end of its stroke, the crank box 35 sliding on rod 36, the impetus which the bell received being expended, it will fall; the set bolt 33 will strike end of rod 36; piston 39 will be forced downward, coming in direct

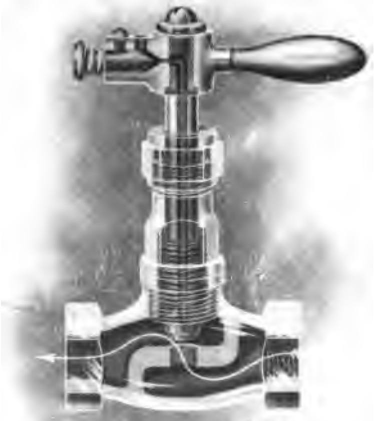


THE GOLMAR BELL RINGER WITH AUTOMATIC STARTER contact with the valve 43, closing exhaust port and opening inlet port after cushioning on the pressure remaining under piston 39 after exhaust has closed. It will be seen that valve 43 is only operated at the termination of the piston 39 stroke. This is the only bell ringer that can be adjusted to use pressure in proportion to the power required. This is accomplished by means of valve stem 42, which is secured in its adjusted position by a pin. No change in length of the connecting rod is required in making this adjustment. Valve adjuster 44 and spring 45 are adjusted so as to keep valve 43 in contact with the side of the cylinder in which the inlet and exhaust ports are placed, so that there is no leakage from one to the other and positive cut off is insured. This type of bell ringer must be operated with air, and not steam.

LEACH "E" DOUBLE SANDER.

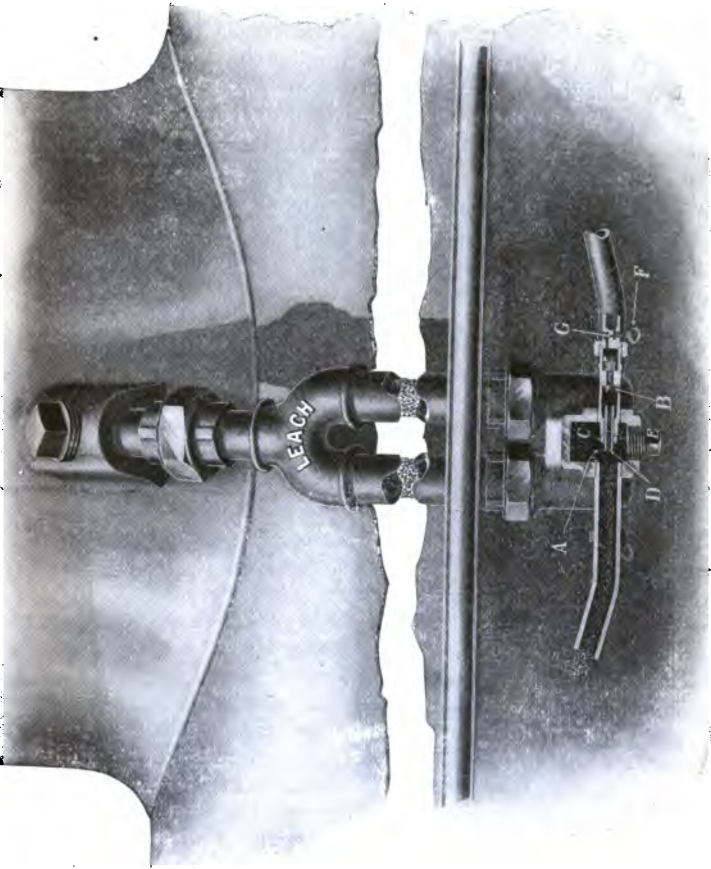
The Sanders illustrated and described represent the highest development of pneumatic track sanders.

Pneumatic sanders are now conceded a necessary part of the equipment of all locomotives; in fact, with the large heavy engines of today, it would be difficult indeed to dispense with their use. The ease of handling them on the part of the engineman is alone a point in their favor that can not be overlooked, as it allows his attention to be given to other duties while the sander is in operation. Pneumatic sanders not only give an instantaneous delivery of sand at the proper time and at the point of contact, but also easily effect a saving of 70 per cent. in the amount of sand used as compared with gravity sand arrangement.



American Locomotive Sander Company Valve, Style E-5

The Leach "E" double sander, with which most of the locomotives throughout the United States, Canada and Mexico are equipped, was designed to meet the extremely heavy service of our heavy power, delivering sand in front of front driving wheels and back of back driving wheels from one sand box, its principal features being that it is an outside sander and adjustable as to amount of sand deliverd. The feed or amount of sand delivered to rail is controlled entirely by the adjusting tube No. 5. Amount of sand may be increased by slacking jam nut No. 4 and screwing the adjusting tube in, and increasing space No. 3, or decreased by screwing adjusting tube out and decreasing space No. 3. You will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readily see by shortening this adjusting tube No. 5 more sand is allowed to fall down in front of tube to be blown out, and lengthening it puts it further away from sand supply and decreases amount of sand delivered to rail.

The adjusting tube is a part of the extension air nozzle, which has a check valve in it to prevent any sand from working through the nozzle and into the air pipes.

The 15-degree bend in the nipples screwed into the sand trap is to prevent sand from working out of its own accord when engine is in motion.

The 1-inch gas pipe plug No. 2, at bottom of sand trap, is for removing small stones, etc. Care should be taken to have nozzles on opposite side of the engine adjusted alike, so as to insure an equal delivery of sand on both sides of the engine. Where more than one delivery pipe is connected to the same trap, provision is made to prevent sand and air going the easiest way, that is, through the shorter delivery pipe. This is accomplished by making the traps with a separate compartment for each delivery wanted, and having a column of sand above each compartment so that the air and sand in one can not cross to the other. Having this column of sand above the trap also provides for accumulating an air pressure in the delivery pipes sufficient to blow out any ordinary obstruction, such as wet sand from the end of delivery pipe, but where any of the joints are loose on delivery pipes, such as nipples working loose in thread where screwed into the sand traps, unions, etc., the efficiency of this feature is lost, for the reason that pressure can not accumulate in delivery pipes, owing to the leaks; and, in consequence, the sander becomes inoperative, and is many times condemned. Unless all joints are kept tight at all times the sander can not work properly.

Many times the sand is found wet in sand traps without any apparent cause, and always, on investigating carefully, some joint is found loose; if not, a cab valve is not tight, allowing enough air to leak through sand to moisten it around end of nozzle.

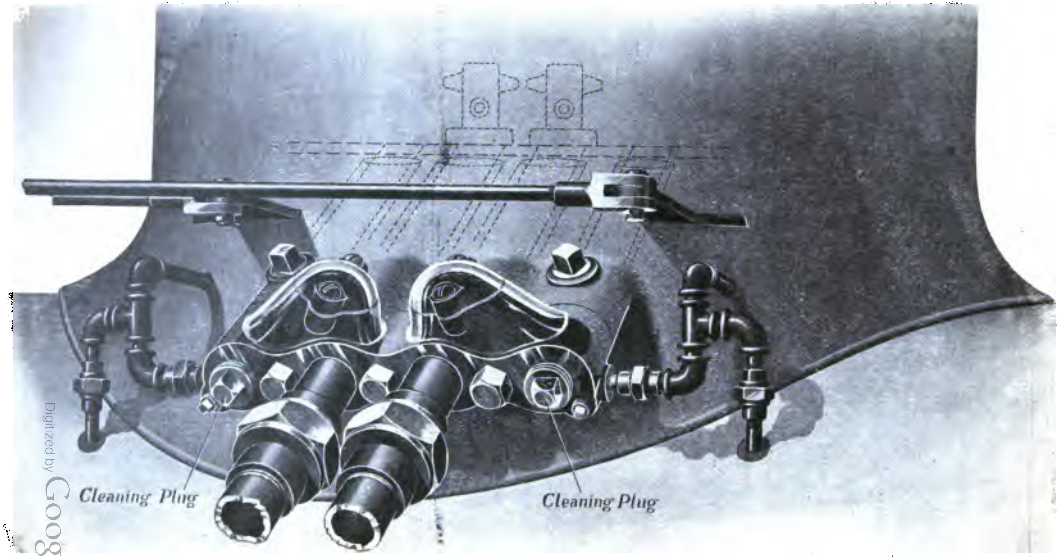
The cab valve shown is the one most generally used, and is specially designed with warning port in handle, so that when sander is on there is a continual reminder that sander is working, and it can not be forgotten and allowed to run until sand box becomes empty. It is the practice of some enginemen to drive a piece of wood in this warning port to prevent the noise. This is WRONG and poor practice, and the sooner you get away from such things the better for all concerned.

LEACH "A" DOUBLE SANDER.

The detail sectional cut of Leach "A" double sander, shown, is the type of sander being more generally applied in the last year or so, owing to the small amount of attention it requires compared to the Leach "E" type of sander. The advantages of this sander are having in connection with it a hand sanding arrangement and a 1-inch delivery pipe from the sand box to the rail, and having only one joint to maintain, as the same delivery pipe serves both the pneumatic and hand sanders. This sander will work a much poorer grade of sand, owing to the larger openings, pipes, etc., and is also an outside sander accessible at all times.

This type of sander is not adjustable as is the case with the Leach "E" sander, but is designed to deliver sufficient sand for average conditions.

The principal features of this type of sander are its simplicity of design, dispensing with all joints possible, and the fact that it requires little or no attention after application, the



LEACH "A" DOUBLE SANDER.

only wearing parts being the blast cap, wihch can be renewed at a very small cost, either on the road or in the roundhouse. The blast cap is also intended for cleaning purposes. Any small stones, sticks, paper, waste, etc., may be removed by taking off the blast cap.

This type of sander is made either single or double, and can be applied to sand boxes on old equipment by changing design of sander to suit conditions, still using hand sander arrangement and pneumatic sander through the one opening in sand box and the same delivery pipe to rail.

Taking into consideration the few points to be kept up on the "A" type of sander, its advantages over other types of sanders can readily be seen. The same cab valve is used with this type of sander as is used with the Leach "E" type sander.

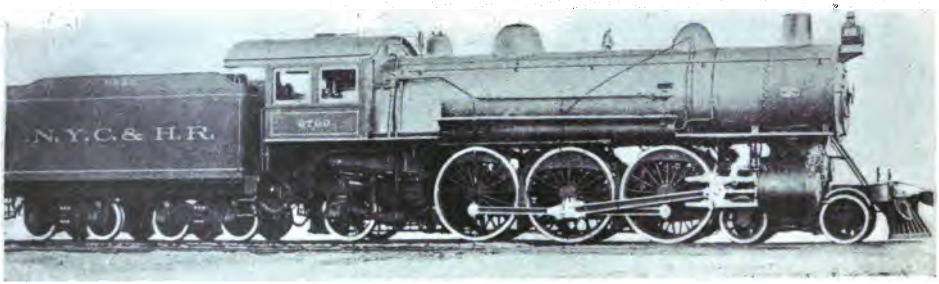
PACIFIC TYPE ENGINE.

Built by the American Locomotive Co. for the N. Y. C. & H. R. R. R.

DIMENSIONS.

Class, 462—218.

Cylinders diameter	22 in.
Boiler:	
Diameter	72 in.
Pressure	200 lbs.
Wheel base:	
Driving	13 ft. 0 in.
Total	33 ft. 7½ in.
Weight:	
On drivers	140.500 lbs.
Total	218,000 lbs.



PACIFIC TYPE ENGINE.

Tank capacity	6,000 U. S. gallons.
Weight of tender, loaded	122,400 lbs.
Heating surface:	
Tubes	3,554 sq. ft.
Fire box	180 sq. ft.
Total	3,758 sq. ft.
Guage	4 ft. 8½ in.
Stroke	26 in.
Driving wheel diameter	75 in.
Fuel, soft coal.	
Fire box:	
Length	96 in.
Width	75 in.
Tubes:	
Number	303
Diameter	2¼ in.
Length	20 ft. 0 in.
Total wheel base, engine and tender	59 ft. 0 in.
Grate area	50.23 sq. ft.
Tractive power	28,500 lbs.
Factor of adhesion	4.92

MAIN AND SIDE RODS.

Q. How should an engine be disconnected on one side?

A. Cover the ports with the valve, so that steam will not appear at either cylinder cock when open. With the throttle slightly open, disconnect the valve stem and securely clamp it; take the main rod down; place the liners, brasses, keys and set screws back in their places; move the crosshead near the back end of the guides, so the back end of crosshead is at the travel mark on the guide, and securely block it there with wooden block (on the most of roads there is a block on each engine for this purpose); do not move the crosshead clear back to the point where it strikes, or the cylinder packing rings may expand in the port or counterbore, and this would cause the shop men trouble.

Q. How should an engine be disconnected on both sides, or be prepared to be towed in?

A. This implies that the engine is dead. To disconnect both sides, remove both main rods and both valve rods; if the crank pins clear the crosshead in all positions it will not be necessary to block crosshead. If the boiler is the cause, in such cases as a blow-off cock, safety valve or whistle being blown out, or hole knocked in boiler, both injectors failing, or failing to have enough water in tank to get to water station, it will not be necessary to do any disconnecting. The cylinders and valves can be kept oiled by putting oil in at the relief valves while the engine is running. On large compound engines having overpass valves on the low-pressure side, remove the caps from the ends of the overpass valve chamber, and take out the valves to prevent the air being churned in the cylinder. In cold weather, when there is danger of freezing when the fire is drawn, the injectors, feed pipes, branch pipes, lubricators and tank must be drained. Air pump exhaust pipe and blower pipe—any part that is liable to be damaged by freezing up—must be drained. In any case that it is necessary to disconnect both sides, to be towed in, the engine should not be hauled at a speed of more than 20 miles per hour, as an engine disconnected on both sides is greatly out of balance, and is liable to break rails.

Q. If the main rod or strap is broken, what should be done?

A. Disconnect on broken side.

Q. In the event of the main crank pin breaking, what should be done?

A. Disconnect on broken side, and take all side rods down. When taking side rods down having solid brasses, always put the washers and nuts back on pin to prevent the threads being damaged. When disconnecting engines and taking side rods down, be sure that the front crank pin will clear the crosshead and key in all positions.

Q. What should be done if the side rod is broken on an eight-wheeled or Atlantic type engine?

A. Take down both side rods. In all cases where there is one side rod taken down, its mate on the opposite side must be taken down, for if it is left up it is subjected to too great a strain, and is liable to break, buckle or break a pin. It is sure to cause more trouble.

Q. If the back section of side rod breaks, on a Mogul engine, what should be done?

A. The knuckle being back of main pin, take off the broken rod and its mate on opposite side.

Q. If the front section of the side rod breaks, on a consolidation engine, what should be done?

A. Take down the broken rod and its mate on opposite side. Be sure that the front crank pin clears the crosshead and key; if the back section breaks, take the broken rod down and its mate; if the middle section breaks, it will be necessary to take down all side rods. To do this, the main rods will have to be taken down in order to get the side rods off. After the side rods are taken down, replace main rods.

Q. If a side rod breaks, on a ten-wheel engine, what should be done?

A. If a section breaks, and the broken rod and its mate can not be taken down on account of the knuckle joint, all side rods must be taken down.

Q. If the main rod on a Rhode Island compound breaks,—low-pressure side,—what should be done?

A. Take down the broken rod, clamp the valve central on its seat, and open exhaust valve in the receiver to the exhaust. Block crosshead at back end of guides.

Q. If rod breaks on high-pressure side?

A. Block crosshead at back end of guides, clamp valve in center of ports. When starting, open throttle gradually.

Q. In the event of a main rod breaking, on either side of Brooks tandem compound, what should be done?

A. Disconnect on the broken side; that is, take down main rod, cover ports with valve, clamp valve stem to hold it there, and block crosshead the same as a simple engine.

Q. If a main rod breaks, on the high-pressure side of a Schenectady compound, how should it be disconnected?

A. Take the rod down, disconnect the valve stem, place valve in the center of its seat, so as to cover both ports; clamp valve stem, and block the crosshead securely. When the throttle is opened, steam will force the reducing valve open, and live steam at a reduced pressure will be supplied to the low-pressure cylinder.

Q. If the main rod breaks, on the low-pressure side, what should be done?

A. Take down the broken rod, disconnect the valve stem, clamp the valve in the center of its seat, block the crosshead, move the handle of the operating valve to simple position. The high-pressure side will then act as a simple engine, the exhaust steam passing out through emergency exhaust valve.

Q. How should a Baldwin two-cylinder compound be disconnected for a broken main rod, high-pressure side?

A. Cover the ports with valve, and clamp it there; take main rod down; block crosshead; place handle of operating valve in simple position. In this way the low-pressure cylinder will receive live steam at a reduced pressure.

Q. On low-pressure side?

A. Cover ports with valve, and clamp valve stem; take main rod down; block crosshead; move handle of operating valve to simple position. In this way the exhaust steam will pass to the amosphere through the emergency exhaust.

Q. How should a Pittsburg compound be disconnected for a broken main rod, high-pressure side?

A. Cover ports with valve, take main rod down, clamp valve stem, block crosshead, move the intercepting valve to simple position, close stop cock to reversing cylinder. In this way the low-pressure cylinder will receive live steam at a reduced pressure.

Q. If the main rod on low-pressure side breaks?

A. Move the reverse lever to the corner, so as to convert her to a simple engine; close the stop cock in pipe to reversing cylinder; cover ports with valve; clamp valve stem; take down main rod; block crosshead; place a piece of wood under each side of the reducing valve spring; tighten nut, so as to hold valve shut against the pressure of steam.

Q. How should a Richmond compound be disconnected for a broken main rod, high-pressure side?

A. Cover ports with valve, clamp valve stem, take down main rod, block crosshead, move handle of operating valve to simple position. In this way the low-pressure cylinder will receive live steam at a reduced pressure.

Q. If main rod on low-pressure side breaks?

A. Cover ports with valve, and clamp valve stem; take down main rod; block crosshead; move handle of operating valve to simple position. In this way the exhaust steam will pass to the atmosphere through emergency exhaust.

Q. How should a Valclain compound be disconnected for a broken main rod?

A. Place valve in center of seat, to cover all ports; take main rod down; block crosshead. If the engine has direct motion, and the valve stem is connected to the crosshead, the crosshead will have to be blocked or clamped in center of guides.

Q. What should be done in the event of a side rod breaking, on a Pacific type engine?

A. Take rods down the same as on a ten-wheel engine.

Q. If the main rod on a Pacific type breaks, what should be done?

A. Cover the ports with the valve; clamp valve stem and disconnect it; take main rod down.

Q. What should be done in the event of the main rod breaking, on an articulated compound?

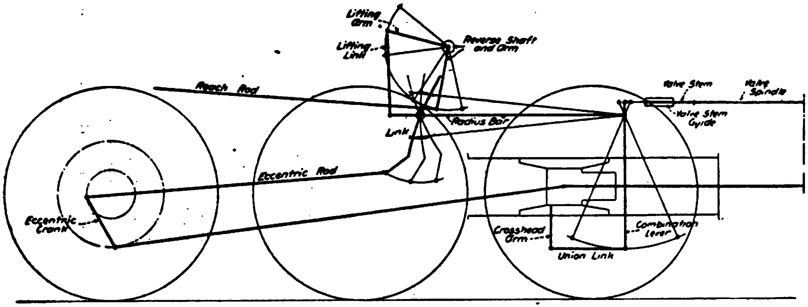
A. Disconnect valve stem; cover ports with valve and clamp valve stem; take main rod down.

Q. In the event of a side rod breaking, on an articulated compound, what should be done?

A. If the front section of side rod breaks, on an articulated compound having the knuckle joint in the front section, it will only be necessary to remove the broken rod and its mate on the opposite side of that engine; that is, on the front or rear engine—the one on which the rod is broken. If the back section breaks, it will be necessary to remove all side rods on that engine. In either case, be sure that the front crank pin will clear the crosshead in all positions.

THE WALSCHAERT VALVE GEAR.

The Walschaert valve gear differs chiefly from the Stephenson link motion, in that it requires for each cylinder but one eccentric or its equivalent to insure the movement of the valve and the proper distribution of steam for both forward and backward motion. The elimination of the heavy eccentrics and their connections relieves the axle of an appreciable portion of its dead weight; it also

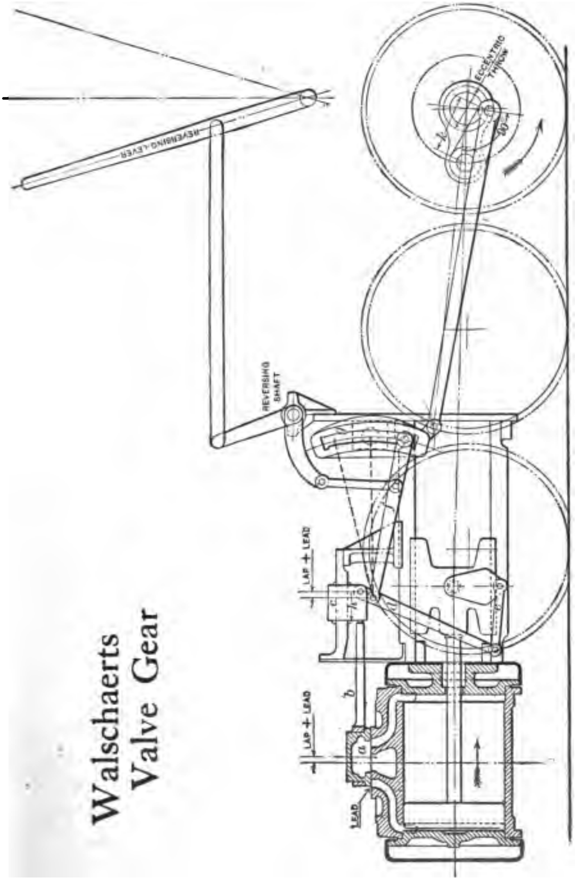


OUTLINE DIAGRAM OF WALSCHAERT VALVE GEAR AS APPLIED TO MALLET ARTICULATED COMPOUND, BALTIMORE & OHIO RAILROAD.

makes it possible to place the gear outside the driving wheels in a more accessible position, where the parts can readily be oiled, inspected and repaired. While it may not be possible to adjust the valve as readily with the Walschaert gear as with the Stephenson motion, for the reason that the parts and connections are not as susceptible to change, it is not as liable to become disarranged, and, if correctly designed and fitted up, will give accurate results with less difficulty in application and greater economy in construction. Equal cut-offs in both ends of the cylinders are more easily secured than with the Stephenson motion, and the play of the engine on its springs has practically no influence on the steam distribution.

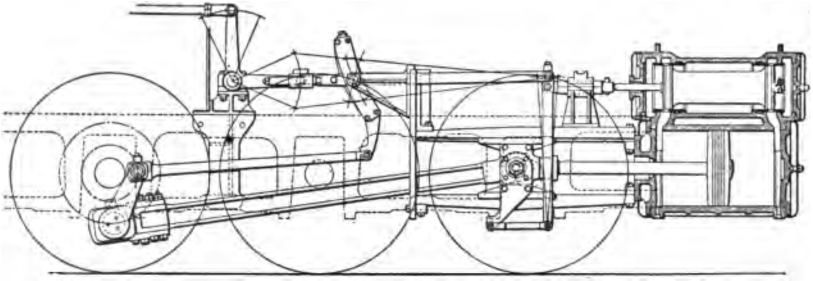
In the Walschaert valve gear the operating eccentric is secured to the driving axle, either directly or by a return crank from one of the crank pins. The position of this eccentric or crank is such as to give the proper valve travel, the throw corresponding with the movement of the valve, irrespective of its lap and lead; the angular advance of the eccentric being O degrees, the link is of any convenient form, and is usually pivoted to a support on the engine frame or suspended from the guide bearer. The trunnion is rigid, and there is no chance for twisting strains. The link is actuated by the eccentric rod, which is commonly attached to its lower extremity. The sliding block in the link is secured to one end of the radius rod. The raising or lowering of this rod, by means of the reversing shaft, shifts the block from one end of the link to the other, above or below the pivotal connection; this reverses the movement of the valve with relation to that of the eccentric.

In many cases the gear can be so designed that the motion is transmitted from the eccentric to the valve stem in one vertical plane, so that practically all of the pins can



Walschaerts Valve Gear

be put in double shear, and all tendency to twist the valve motion is avoided. In some cases, as with the Chicago, Rock Island and Pacific locomotives, it is necessary to have the eccentric and the valve stem in different vertical planes. In such cases it is not practicable to have all the pins in double shear, but the valve motion can be made of a high degree of simplicity and solidity. It is sometimes urged against the Walschaert motion that it requires more moving parts than the Stephenson; this is, however, offset by the better opportunities for solid construction and ready inspection and adjustment. The end of the radius rod opposite the link is attached to a combining lever, the function of which is to give the required lap and lead to the valve. The lower end of this lever is connected to and travels with the crosshead, while the upper end is secured to both the valve rod and the radius rod, one being placed above the other; the point at which the radius rod is attached to the combining lever becomes a fulcrum. The relative movement of the two ends of the lever must be such that the full movement of the crosshead imparted to the lower end of the lever will give a movement of the upper end equivalent to the required lap, plus the lead. Under ordinary conditions, with steam chest valves having outside admission, the connection or fulcrum between the radius rod and the combining lever is placed below the valve rod connection; with valves having inside admission this fulcrum is usually placed above the valve rod connection. The link should have a radius equal to the length of the radius rod. If this is so, it will be seen that when the engine is on the dead center the link block can be moved from end to end of the link without altering the position of the valve with relation to the ports, and the lead will be constant. As any variation in the length or elative position of the link the radius rod and the com-



Walschaerts Valve Gear as applied to Consolidation Freight Locomotive, Lake Shore and Michigan Southern Railway—Illustrating a Cross-section through Cylinder and Valve

bining lever or its connections will necessarily change the resulting movement of the valve, it is absolutely essential, first, that the motion shall be correctly designed and plotted; second, that the detail parts shall be accurately constructed according to a diagram. With those two points assured, the adjustment of the gear on the locomotive is quite simple. The dead center marks on the rim of the driving wheels and the port tram marks on the valve stem are found in the usual manner. After connecting the gear, any slight variation which may occur between the forward and backward position of the valve can be adjusted by lengthening or shortening the eccentric rod.

Q. How can the valves on an engine having the Walschaert valve gear be squared, adjusted, when they get out of square, get lame?

A. The lap and lead are determined by the proportion of the arms of the combining lever and the stroke of the piston. The amount is found by turning the engine from one dead center to the other center in any cut-off position.

(1) The motion must be adjusted with the cranks on the dead center by lengthening or shortening the eccentric rods until the link takes such a position as to impart no motion to the valve when the link block is moved from its extreme forward to its extreme backward position. Before this change in the eccentric is resorted to, the length of the valve stem should be examined, as it may be of advantage to plane off, or line under, the foot of the link support, which might correct the lengths of both rods, or at least only one of those should need to be changed.

(2) The difference between the two positions of the valve on the forward and back centers is the lap and lead doubled, and can not be changed except by changing the leverage relations of the combining lever.

(3) A given lead determines the lap, or a given lap determines the lead, and it must be divided for both ends as desired by lengthening or shortening the valve spindle.

(4) Within certain limits this adjustment may be made by shortening or lengthening the radius bar, but it is desirable to keep the length of this bar equal to the radius of the links in order to meet the requirements of the first condition.

(5) The lead may be increased by reducing the lap and the cut-off point will then be slightly advanced. Increasing the lap introduces the opposite effect on the cut-off. With good judgment, those quantities may be varied to offset their irregularities inherent in transforming rotary into lineal motions.

(6) Slight variation may be made in the cut-off points as covered by the previous paragraph, but an independent adjustment can not be made except by shifting the location of suspension point, which is preferably determined by a model.

Q. In the event of a breakdown, when it becomes necessary to disconnect one side of an engine having the Walschaert valve gear, what shall be done?

A. If possible, take down the eccentric rod. The combining lever should be uncoupled from crosshead and securely fastened in forward position. If for any reason the eccentric rod can not be taken down, the radius rod must be removed, in order that no motion may be imparted to the valve. The valve can then be placed in central position, and held by suitable blocking or by clamping the valve rod; this seals both steam ports and cuts out the damaged side.

BROKEN VALVE, VALVE SEAT, VALVE YOKE OR STEM.

Q. If the valve yoke is broken, what should be done?

A. Take off the steam-chest cover, disconnect the valve stem, cover the ports with valve, fit blocks of wood between the valve and steam chest (both front and back sides) to hold valve central on seat, clamp the valve stem in gland, replace steam-chest cover, take down main rod on that side, block crosshead at back end of guides.

Q. In the event of a bridge breaking, what should be done?

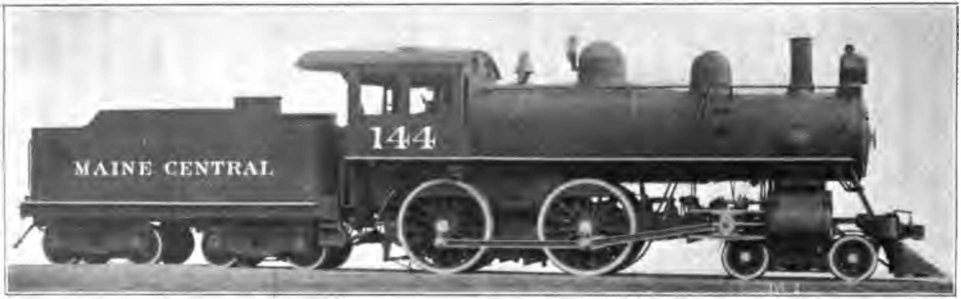
A. Cover ports with valve; disconnect valve stem, and clamp it; take down main rod; block crosshead at back end of guides.

Q. If the valve is broken, what should be done?

A. If, after the steam-chest cover has been removed, the valve is found to be broken in such a manner that the ports can not be covered with it, remove the valve and yoke; get a large wooden block, and cover the supply ports; drive a wooden plug in valve stem hole from the inside; screw down the steam-chest cover so that it will hold the block in place (a board can not be used under a balanced valve); take down the main rod on that side; block the crosshead, at back end of guides, securely.

Q. In case the valve stem is broken, what should be done?

A. Take off the steam-chest cover; cover the ports with the valve; if there is enough of the valve stem left fast to the yoke to calmp, clamp it; if not, block the valve central on its seat by placing blocks of wood on the front and back sides of the valve, between the valve and steam chest; plug the valve-stem hole, from the inside, with a wooden plug; take down the main rod on that side; securely block the crosshead at back end of guides.



Eight Wheel Built by the American Locomotive Company.

Q. What should be done in the event of the outer wall breaking? that is, the wall between the supply and admission ports.

A. Disconnect the valve stem; move the valve until it connects the unbroken port with the exhaust, and clamp it there; dsiconnect the main rod, and move the piston to the end of the cylinder opposite the broken ports, and block it there very securely; remove the cylinder cock from that end of cylinder.

Q. If a false valve seat is broken, what should be done?

A. If the false seat is broken in such a manner that it can not be fitted together steam-tight, take it out and drop the valve down, and see if it will cover ports; if it will, clamp valve stem; if it will not, take it out, and also the yoke; place a piece of board over ports, and block on top of that, so as to hold it in place; plug valve-stem hole from inside with wooden plug; take down main rod on that side; block crosshead at back end of guides.

Q. If the valve stem breaks on a Rhode Island, Schenectady, Baldwin Two Cylinder, Pittsburg, Richmond or Baldwin Vauclain Compound, how should the engine be disconnected?

A. The same way as for a broken main rod on the same side.

BROKEN CROSSHEAD, BROKEN GUIDE, OR PISTON ROD BROKEN OR BENT.

Q. If the crosshead is broken, what shall be done?

A. Take down the main rod, disconnect the valve stem. If there is enough of the crosshead left to block, block it at back end of guides, cover ports with valve, and clamp valve stem. If there is not enough left to block, move the piston to the back end of the cylinder, and place the valve in such a position as to admit steam in the front port, and clamp it there securely. Remove the back cylinder cock. If there is only a crosshead gib broken, replace it if there is one on the engine; if not, use a piece of board instead. With engines having crosshead gibs, it is well to see that there is an extra gib on engine before leaving engine house, as it will save trouble in case one breaks.

Q. What should be done in the event of a guide breaking?

A. If the guide bar is broken, disconnect on that side; or if a guide yoke is broken or bent so that it will not hold the guides secure, disconnect on that side. An engine having four bar guides can be run ahead with one of the bottom guide bars broken or gone; but it is not safe to run engine backward in this condition. When an engine is running ahead the crosshead is held up against the top guide.

Q. If the piston rod is broken, what should be done?

A. When a piston rod breaks, it nearly always knocks out the front cylinder head; if there is no other damage than the piston rod and front cylinder head broken, remove the piston from the cylinder if it not already out; disconnect the valve stem; cover ports with valve, and clamp the stem. In this case it is not necessary to take down main rod.

Q. If the piston rod is bent, what should be done?

A. Disconnect that side of engine.

Q. In the event of the high-pressure piston rod or cylinder head breaking, on a Valclain compound engine, what should be done?

A. Remove the broken piston, and clamp a heavy board on end of cylinder, making a steam-tight joint. The steam will then pass direct to the low-pressure cylinder.

Q. If the low-pressure piston rod or cylinder head breaks, on a Valclain compound engine, what should be done?

A. Remove the piston rod, if broken, or pieces of cylinder head, and board up the end of cylinder as near steam-tight as it can be. If it can not be boarded up tight enough to make it safe to run in, on account of escaping steam, with either high or low-pressure cylinder, disconnect that side of engine.

BROKEN ENGINE FRAME. BROKEN DRIVING BOX OR BRASS.

Q. What should be done in the event of the engine frame breaking?

A. If the frame breaks between the main driving box and the cylinder, and the break opens much when engine is working, the engineman will have to use his own judgment as to whether he will take the whole train in, or a part of it; and whether he will disconnect that side of engine or not; but under no circumstances let another engine couple ahead to assist, as this is almost sure to cause more trouble.

Q. In the event of a driving-box brass breaking, what should be done?

A. If the driving-box brass is broken and cutting badly, run that wheel up on a thin wedge, and block between the top of the frame and spring saddle with iron blocks. This will take part of the weight off. Use plenty of oil.

BROKEN STEAM CHEST.

Q. What is the usual cause of breaking a steam chest?

A. Reversing the engine, when running at a high rate of speed, without opening the throttle first.

Q. What should be done in the event of a steam chest breaking?

A. Remove the casing, and, if it is only cracked on one side, drive iron wedges in between the chest and studs. In this way it can be made tight enough to get in. Break-shoe keys are good to use for wedges in this case. If the side is cracked in more than one place, or the cover is broke, disconnect that side of engine; remove the chest cover, and plug up the supply ports with wood, and clamp the plugs with steam-chest studs. If steam enters from side of chest, use a blind gasket there.

BROKEN CYLINDER HEADS.

Q. What should be done in the event of the back cylinder head breaking?

A. Disconnect the engine on broken side, and if necessary to remove the guides and broken head, then remove the piston also.

Q. If the forward head breaks, what should be done?

A. Disconnect that side of engine.

Q. What should be done in case both forward heads break?

A. If both pistons are all right, and both forward steam ports can be properly blocked, the engine can handle itself. Block steam ports, not the supply ports.

BROKEN HAND GEAR.

Q. What should be done in the event of the reverse lever, reach rod or top tumbling-shaft arm breaking?

A. If the engine is to run forward, the links should be raised to the proper height for handling her train, a block of wood placed in the slot of the link, between the top of the link and link block, and fastened securely. In this condition an engine can not be reversed while in motion. If it becomes necessary to run backward, change the block for a longer one to raise the link to the proper height for back motion. It is not necessary to block more than one link. Run carefully.

Q. What should be done in case the link hanger, saddle pin or tumbling-shaft lifting arm breaks?

A. Drop the link on the good side far enough so the engine can handle her train. Measure the distance between the top of the link slot and top of link block on good side, and put a block of that length into the link slot on the broken side. Do not drop good side, as most engines are so constructed that the tumbling-shaft arm on the broken side will drop in behind the top of the link when in full forward gear, and that would cause more trouble. In this case, as in the case of the broken reverse lever, the engine can not be reversed without changing the block for a longer one.

Q. What should be done in the event of the top or bottom rocker arm breaking?

A. If the top arm breaks, disconnect that side; if the bottom arm breaks, disconnect that side. Remove the broken parts of the rocker arm. If the link will clear everything in both forward and backward gear, the eccentric straps can be left up; if there is any doubt about the link clearing, remove the eccentric straps and rods, and tie the top of the link to the lifting arm of the tumbling shaft to keep it from tipping over, which might prevent reversing the engine.

Q. What should be done in case rocker pins break?

A. If the top pin breaks disconnect that side. If the bottom pin breaks it is sometimes possible to remove the top pin, and turn the bottom arm up high enough to clear the link, and tie it up to the guide yoke. If this can not be done so there is no doubt about the link clearing, remove both eccentric straps and rods, tie the link to the lifting arm of the tumbling shaft, to keep it from tipping over. Disconnect this side.

Q. What should be done in case the forward motion eccentric strap or rod breaks?

A. Disconnect that side, and take down both straps and rods on that side. Tie the top of the link to the lifting arm of the tumbling shaft.

Q. What should be done in case the back motion eccentric strap or rod breaks?

A. The engine can be run ahead, with the reverse lever in full forward gear, by taking down the broken strap and rod, if the bottom of the link can be fastened so that it can not swing back and forth. If the engine is run in this condition, she must not be reversed. If the link can not be fastened, both forward and back, so it can not swing, take down both straps and rods on that side, and disconnect.

Q. How can a slipped eccentric be located?

A. If the exhaust suddenly goes badly out of square, close the throttle. Do not move the reverse lever. Stop the train. First examine for a broken frame; it is more liable to be a broken frame between the main driver box and the cylinder than it is a slipped eccentric. Examine for loose nuts on the eccentric-strap bolts, also the bolts in back end of the eccentric rods. If the frame and eccentric-strap bolts and rod bolts are all right, place the reverse lever in the forward full gear, open the cylinder cocks, start the train slowly, and watch if the steam discharges from the cylinder cocks on either cylinder the instant the crosshead reverses its motion. It should do this, and if it does not at one cylinder cock, the slipped eccentric is the forward motion on that side; if the valves are square, in full gear, and are out in the usual working notch, it would indicate that trouble is in the back motion eccentric. The effect of a slipped eccentric is to either increase or decrease the lead, depending on whether it is slipped toward or away from the main pin.

Q. How can slipped eccentric be set out on the road if there are no key ways or marks to set them by?

A. If the forward motion eccentric is slipped, place the engine on that side on either center; place the reverse lever in the back notch of the quadrant, and scratch a line with a knife on the valve stem, right at the gland; then place the reverse lever in the forward notch, and move the slipped eccentric until the line comes to the gland again; then fasten the set screws. The valve will be square enough for the engine to haul her train in (of course care being taken that the bellies crank arms of the eccentric are not on the same side of the axle). If the back motion is slipped, place the engine on that side, on her center; place the reverse lever in forward full gear; clamp the valve stem so that it can not move; reomve the bolt connecting the back motion eccentric rod to the link; place the reverse lever in full gear back; move the slipped eccentric until the connecting bolt can be put in again, being careful that the bellies crank arms of the two eccentrics on that side are on opposite sides of the axle. If both eccentrics on one side are slipped, place the engine on the forward center on that side; open cylinder cocks, and place the forward-motion eccentric above the axle, and the back-motion below the axle; place the reverse lever in forward full gear, and advance the top eccentric until the front cylinder cock shows steam (the wheels being blocked and the throttle very slightly open); then fasten the set screws on the forward-motion eccentric. To set the back-motion eccentric, the reverse lever may be placed in the back full gear, and the bottom eccentric turned towards the crank pin until steam shows at the front cylinder cock; or the back-motion eccentric may be set by the forward-motion one, which has just been set, as though the forward-motion one had not slipped.

Q. How can some of the breaks of the hand gear be prevented?

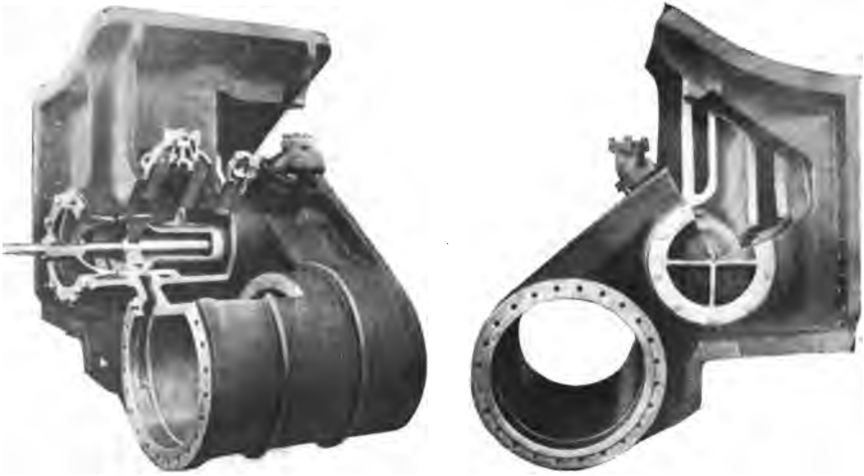
A. By closely watching the nuts on the link-jaw bolts, eccentric-strap bolts, eccentric-rod bolts, link-block bolts and link-hanger bolts, and keep them tight, and see that the keys are in place.

THE PISTON VALVE.

The development of the locomotive having involved both larger cylinders and higher pressure, there has been a corresponding evolution from the slide valve to the piston valve, the latter giving the necessary increase in port areas, and so perfectly balanced as to minimize friction. The relative arrangement of cylinder and piston valve is shown by the cut opposite. The valve is of the internal admission type, and the steam passage from the top of the saddle is therefore short, direct, of large cross section, and, being embraced between valve chamber and cylinder, are short, direct, of large area, and offer minimum frictional resistance to the flow of steam, whether admission or exhaust.

Attention is called to the fact that the valve packing rings overlap the adjacent parts of the valve; this secures unrestricted port openings and reduces wire drawing to a minimum.

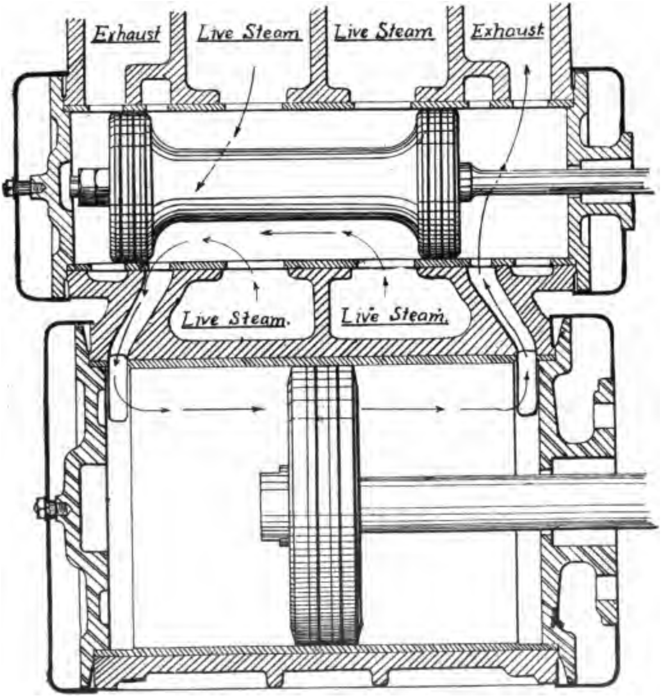
The by-pass valves have two functions—first, as safety valves against excess pressure in the cylinder; the valve chamber end of these valves being of larger area than their cylinder ends, they remain closed under normal running conditions when the throttle is open, the valve chamber steam pressure then being greater than the cylinder pressure; under any abnormal or exceptional conditions when the cylinder pressure for a moment might be high, it would automatically relieve itself into the valve chamber through these relief valves. Their second function is to automatically open communication between the two



No. 23

Section of Cylinder with Inside Admission Piston Valve.

No 26



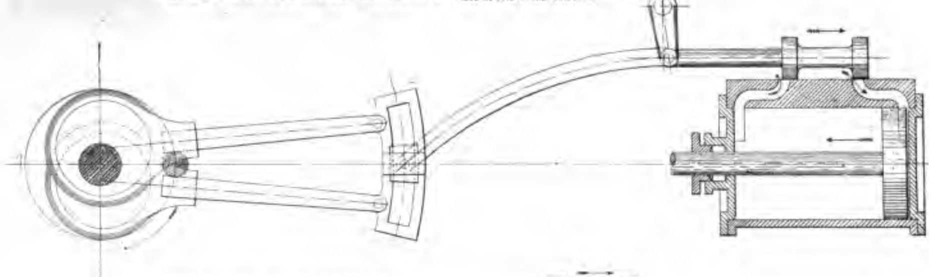
ends of the cylinder when the engine is drifting; that is, when the throttle is closed; the pressure in the two ends of the cylinder and in the central chamber of the valve is thus equalized. Dash pots protect these relief valves from sudden blows.

Piston valves, when used on single expansion locomotives, are usually arranged for inside admission. The valve is cast hollow, so that the exhaust steam can circulate through the interior, thus the only unbalanced area in the cross section of the valve stem, and when this is extended through the front steam chest head, the valve is completely balanced. The live steam is conveyed through the center of the cylinder casting, hence the steam does not come in contact with the external walls, and condensation is reduced to a minimum. The construction of the cylinder is shown on card No. 26. The sectional drawing through the cylinder and steam chest shows the relative positions of the valve and piston when the latter is on the backward stroke, and the front steam port is wide open. The arrows indicate the course of the steam.

The valves on a locomotive of this type are set in a manner similar to those on a slide valve engine. As the steam edges of the valve are not visible when the steam chest heads are removed, peep holes are provided for observing the lead. These are drilled through the wall of the casting on the center lines of the admission ports and are closed by brass plugs.

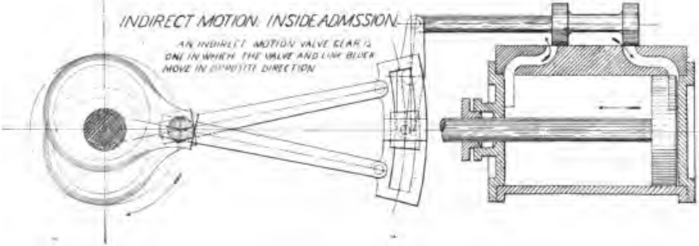
Direct valve motion is frequently used when the location of the steam chest is such that it can be conveniently applied, as in cut No. 23, but when the steam chest is placed above the cylinder a rocker is employed, as on a slide valve engine. A locomotive having piston valves with inside admission and direct motion, each valve is driven through a rock shaft whose bearing is bolted to the guide yoke.

DIRECT MOTION. INSIDE ADMISSION. A DIRECT MOTION VALVE GEAR IS ONE IN WHICH THE VALVE AND LINK BLOCK MOVE IN THE SAME DIRECTION



INDIRECT MOTION. INSIDE ADMSSION.

AN INDIRECT MOTION VALVE GEAR IS ONE IN WHICH THE VALVE AND LINK BLOCK MOVE IN OPPOSITE DIRECTION



Both arms of the rock shaft point downward or upward, so that the valve motion is not reversed. The inner arm of the rock shaft is connected to the link block by a transmission bar, which passes above the leading driver—axle. This bar is suspended forward of the link by a suitable hanger. The eccentric rods are similar to those used on a slide valve engine. When an inside admission piston valve is used with direct valve motion, the eccentrics occupy the same position, relative to the crank pin, as on a slide valve engine with indirect valve motion; that is, when the pin is on the forward center the rods will not be crossed.

Q. How can a slipped eccentric be set on an engine having direct motion.

A. The rule given in broken hand gear will apply to either direct or indirect motion, so far as setting the single slipped eccentric, but will have to be changed for both eccentrics slipped. There will be two changes, as follows: In place of setting engine on forward center, set it on back center; then proceed as directed, except that the steam must show at back cylinder cock instead of front.

Q. What should be done in the event of a transmission bar breaking?

A. Disconnect that side of engine and take broken transmission bar down.

BROKEN OR DISCONNECTED THROTTLE ROD.

Q. In the event of the throttle rod breaking or becoming disconnected, what should be done?

A. If the throttle rod breaks or becomes disconnected, and the throttle can not be closed, apply the brake to stop or keep the train under control. Start the injector; open safety valve; disconnect blower pipe at front end, outside of smoke box, and open blower valve. This will help to reduce pressure. Dampen fire down with wet coal. After the pressure has been reduced so that the engine can be handled with reverse lever and brake, if the train can be pulled in on a side track, safely, pull it in, and then cut engine off and take it to shop. It is not safe to take train in with engine in this condition.

Q. If throttle becomes disconnected or closed, and can not be opened, what should be done?

A. Ask for help and prepare to be towed in. In a case of this kind it will not be necessary to do any disconnecting. The valves and cylinders can be oiled with the lubricator. If the engine is a two-cylinder compound, having over-pass valves, it is well to remove the caps from the ends of the over-pass valve chamber, and take out the valves to prevent churning air in the cylinder.

BOILERS.

Q. What will cause a boiler to foam?

A. Grease, soap, some kinds of oil, alkali or soda in excess, or any substance that will cause the formation of suds.

Q. What should be done when a boiler is thought to be foaming?

A. Close the throttle slowly; if the water level is high, and it remains at the same height when the throttle is closed, the boiler has been filled too full of water, and is not foaming. In closing the throttle, if the water falls very rapidly and appears in a riled condition in the water-gauge glass, this would indicate that the boiler is, most likely, foaming. In a case where the boiler is found to be foaming, do not close the throttle; open the cylinder cocks; place the reverse lever in the corner; put both injectors on; keep the engine in motion until there is a safe water lever obtained; then open the surface cock and blow off some of the bad water. Bear in mind that when a boiler is foaming that the crown sheet is in danger of being over-heated. At the end of the trip have boiler washed out, and the tank cleaned out to prevent the recurrence of the trouble.

Q. What will cause an engine to prime; that is, to work water in the cylinders and throw it out the stack when the boiler is not foaming?

A. Insufficient steam space will cause it; 99 times out of 100 it is caused by there being a high-water man in the cab.

Q. What is the effect of an engine priming?

A. It decreases the power of the engine, as wet steam has less expansive power than dry steam; it endangers the cylinder heads, as water is alomst incompressible; it washes the oil from the valves and cylinders, and also from the steam cylinder of the air pump.

Q. What should be done in case a flue should burst?

A. Put on one or both injectors, if necessary, to keep the water up. If there is no arch in fire box, the flue can be plugged after the pressure has been reduced—with iron plugs if the engine is provided with them; if not they can be plugged with wood. Wood will not burn inside of the flue sheet. Sharpen the end of a pale, and drive it into the flue. Plug the fire-box end first, and then the front end.

Q. What should be done in case a safety valve or whistle should blow out?

A. Start both injectors at once. Kill or smother the fire. If, after sufficiently cool, there is a safe amount of water in the boiler, drive a soft wooden plug into the hole, and fire up again—but keep the pressure low.

Q. What should be done in case the blow-off cock should be blown out, or a hole knocked in boiler?

A. Start both injectors; drown fire out; prepare to be towed in.

Q. In case both injectors fail to work, what should be done?

A. Use every effort to get them to work. Knock the fire out before the water gets below a safe limit.

Q. What is the least depth of water that is safe on a crown sheet?

A. 3 inches.

Q. If for any cause the water is allowed to get very low in the boiler—near the danger line,—and the injectors will work, what should be done?

A. Keep one injector working, throttle open, fire bright, engine in motion. Do not go over a summit until there is enough water in boiler to be safe, as this will change the water level in boiler.

Q. What effect will the upper valve being stopped up have on the reading of the water in a water-gauge glass?

A. The pressure in the boiler will force sufficient water into the glass to fill it, and it will remain full regardless of the height of water in the boiler.

Q. What effect will the lower valve being stopped up have?

A. The water will not fluctuate in the glass, which will fill by condensation, and remain full. The blow-off cock at the bottom of the lower valve should be frequently opened, and a free circulation between the boiler and glass should be kept, always. If the water in the glass does not play up and down when the engine is in motion, there is something wrong with the valves, and the glass should not be depended on. Remember the gauge cocks work in conjunction with the water glass.

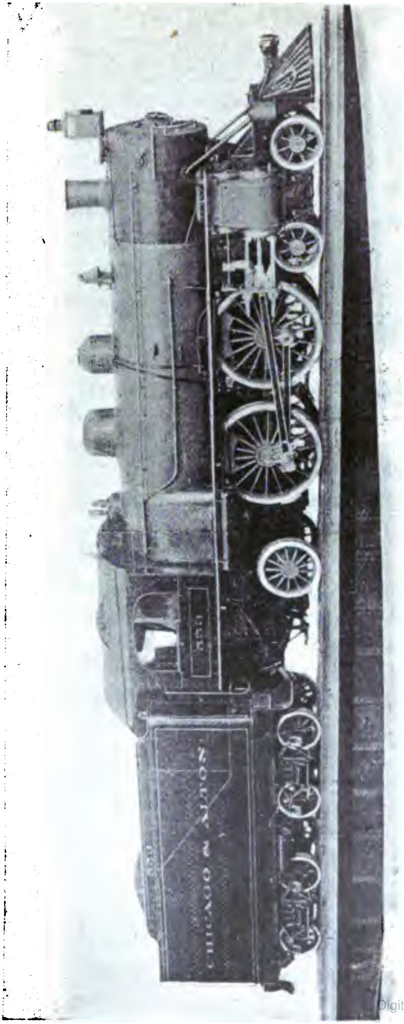
Q. What should be done in case some of the grates burn off?

A. Clean out the ash pan, build up from the bottom of the ash pan to the grates with stone and splice bars to prevent the fire coming down into ash pan, and burning off more grates.

ATLANTIC TYPE ENGINE.

Built by the Baldwin Locomotive Works for Chicago and Alton Railway Co.

Class, 1034¼ C 13.	
Road No. 553.	
Gauge	48½
Cylinders	20 in. x 28 in.
Valves, balanced piston.	
Boiler:	
Type, straight	
Material, steel	
Diameter	70 in.
Thickness of sheets	⅝ in.
Working pressure	200 lbs
Fuel, soft coal.	
Staying, T crown bars.	
Fire box:	
Material, steel.	
Length	108⅛ in.
Width	72¼ in.
Depth, front	71⅜ in.
Depth, back	57⅞ in.
Thickness of sheets, sides	⅜ in.
Thickness of sheets, back	⅜ in.
Thickness of sheets, crown	¾ in.
Thickness of sheets, tubes	½ in.



Atlantic Type Engine.

Water space:	
Front	4½ in.
Sides	5½ in.
Back	3½ in.
Tubes:	
Material, iron.	
Wire gauge, No. 11.	
Number	326
Diameter	2¼ in.
Length	16 ft. 0 in.
Heating surface:	
Fire box	191.2 sq. ft.
Tubes	3,056 sq. ft.
Total	3,247.2 sq. ft.
Grate area	54.2 sq. ft.
Driving wheels:	
Diameter of outside	80 in.
Diameter of inside	73 in.
Journals:	
Main	10 in. x 12 in.
Others	10 in. x 12 in.
Engine truck wheels:	
Front	36 in.
Journals	6½ in. x 12¼ in.
Trailing wheels:	
Diameter	48 in.
Journals	8 in. x 12 in.
Wheel base:	
Driving	7 ft. 8 in.
Rigid	15 ft. 8 in.
Total engine	27 ft. 0 in.
Engine and tender	56 ft. 3½ in.

Weight:	
On driving wheels	103,690 lbs.
On front truck	40,130 lbs.
On trailing wheels	40,000 lbs.
Total engine	183,820 lbs.
Total engine and tender about	340,000 lbs.
Tender:	
Wheel No. 8.	
Diameter	36 in.
Journals	5½ in. x 10 in.
Tank capacity	8,400 gallons.
Service, passenger.	

BAD STEAMING ENGINES.

Q. What will cause engines to be bad steamers, aside from faulty design?—of which there are very few.

A. Exhaust column being loose at its base; nozzle being loose on column; the diaphragm being too low; the netting in the extension front clogged up; the nozzle being too large; the exhaust steam not entering the stack centrally; the exhaust steam not expanding sufficiently to fill the stack before it is near the top; the exhaust steam expanding so rapidly after leaving the nozzle that it not only fills the stack at the base, but some of it strikes the smoke arch, below the stack; if with a diamond stack, the netting in stack clogged up, or the petticoat pipe out of line with the stack; if the stack and the exhaust column and nozzle are properly designed and adjusted to give the required vacuum to cause the engine to steam good, the vacuum may be partly destroyed by steam leaking into front end from steam pipes or base of exhaust column, if loose, or air leaking into front from outside.

Q. What is one of the most common causes of engine steaming badly?

A. Flues being stopped up. Say there are 20 flues stopped up, which is often the case. 20 flues at 2¼ inches diameter, 13 feet long, means about 153 square feet of indirect heating surface, aside from the amount of draft it cuts off the fire.

BLOWS.

Q. What are some of the defects that will cause an engine to blow?

A. A broken bridge, or crack or sand hole in bridge, a broken valve, a valve yoke cracked or broken on one side, balance strips or rings broken or stuck down, broken springs under balance strips, leak in steam pipe, a valve stem broken, valves traveling too far, broken or badly worn piston packing rings, or rings that have worked around so that the joint is at the top or side of the cylinder, the outer wall of steam port being broken.

Q. When there is a blow in an engine, how can it usually be located?

A. Place the crank pin, on the side of the engine the blow is thought to be in, on the top quarter; the reverse lever in center of quadrant; set the brake; open the cylinder cocks; open the throttle enough to admit a little steam. If no steam appears at the cylinder cocks, the valve and seat are all right on that side. Test the other side the same way. If steam blows through the cylinder cocks it shows that there is a leak between the valve and seat. If the blow is caused by the balance strips or rings, steam will go direct through the exhaust column, and out the stack.

Q. How can it be determined if it is a hole in bridge, or cracked or broken bridge causing the blow?

A. It can usually be determined in this way: place the main pin of the engine on the top quarter on the side the blow is thought to be; set the brake; place the reverse lever in forward full gear; open the throttle a little so as to admit steam into steam chest. With the engine and reverse lever in this position, if the back bridge is broken, there will be a very heavy blow; if the bridge has sand hole in it, or is cracked, there will be a blow, but not as heavy as if the bridge is broken; this blow will stop as soon as the reverse lever is moved to back full gear, if the front bridge is not broken also. If, after testing in this manner, the back bridge is found to be all right, test for the front bridge by placing the reverse lever in back full gear: if the front bridge is the cause of the blow, the blow will start as soon as the reverse lever is placed in back full gear, and stop when moved to forward full gear. If the trouble is not found on the side first tested, test the other side in the same manner.

Q. How can it be determined if it is a broken valve causing the blow, or not?

A. Usually, in this way: Place the main pin, on the side of the engine that blow is thought to be, on top quarter, and the reverse lever in center of quadrant; set the brake; open the cylinder cocks; give her a little steam. If a blow occurs, and steam appears at one of the cylinder cocks, it would indicate a broken valve, as a broken valve will allow steam to escape to the exhaust and to one of the steam ports. If the trouble is not found on the side first tested, test the other side in the same way.

.Q How can it be determined if a broken or cracked valve yoke is causing the blow?

A. This will usually be indicated by the engine having three perfect exhausts and a heavy blow instead of the fourth exhaust.

Q. How will blow caused by a steam-pipe leak be indicated?

A. This will not cause a blow in the stack; if a bad leak it will be indicated in the draft on the fire.

Q. How will blow caused by a broken valve stem be indicated?

A. By a tremendous blow all the time the throttle is open. The position of the valve can not be changed by the reverse lever.

Q. How will a blow be indicated that is caused by valves traveling too far?

A. This blow will only occur when the engine is working in full gear, and will disappear when the engine is cut back. It is sometimes caused by the top arm of the tumbling shaft being bent or working loose—caused by the key being lost.

Q. How will a blow caused by the outer wall of the steam port being broken be indicated?

A. There will be a constant blow out of the cylinder cock at that end of the cylinder, if open; as long as the throttle is open, the ports can not be covered with valve.

Q. How can it be determined if the piston packing rings are blowing?

A. Place the engine, on the side to be tested, on the forward bottom eighth or bottom quarter; set the brake; open the cylinder cocks; open the throttle. If steam only appears at one cylinder cock, the piston packing on that side is all right. A blow caused by broken piston packing rings will weaken the exhaust on that side of engine. Piston packing blows are the heaviest on the first half stroke.

Q. How can it be determined in which steam chest a blow is?

A. If the engine has a double nozzle, the surest way is to open the front end, and see which nozzle the steam comes out of when testing for blows. If the engine has a single nozzle, it can usually be determined by getting up on the boiler, and holding a lighted torch on each side of the stack: the side of the stack the draft is the strongest, the blow will be in the opposite steam chest.

Q. How can a test be made to determine if the packing rings on a piston valve are blowing?

A. Place the valve in the center of its travel, and open the throttle a little. If the ring or bushing are bad, this will cause a blow.

POUNDS.

Q. What are some of the most common causes of engines pounding?

A. Too much play between the guide bars and the crosshead will cause a pound when the engine is working hard and running slow; a piston being loose on the piston rod, or the rod loose in the crosshead will cause a heavy pound; loose crosshead pin, loose crank pin, broken engine frame, loose wedges in driving-box jaws, worn main-rod brasses, or the brasses loose in the straps, worn side rod brasses or knuckle pins will cause a pound, but not a heavy one; if the main rod is lined out too far ahead or lined out too far back, so that the piston will strike the front or back cylinder head, it will cause a pound; a badly worn driver ,box will cause a poung.

Q. How can pounds be located?

A. Place the crank pins on the top quarter on the side of the engine to be tested; block the drivers, or set the tank brake; have the fireman to give her a little steam, and reverse her several times, while all the points on that side where pounds are liable to occur are examined. A pound caused by piston being loose on the piston rod, or a badly worn driver box, are the hardest pounds to locate. Pounds caused by the main rod being lined out too far either way, allowing the piston to strike the cylinder heads, can be located while the engine is drifting.

VALVE-STEM AND PISTON-ROD PACKING.

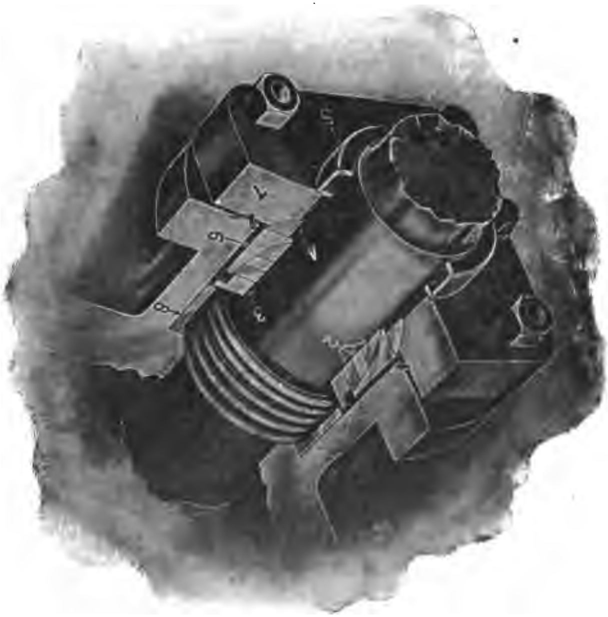
The United States Metallic Packing is the standard locomotive packing on more than 85 per cent. of the railroads of this country.

Q. Of what is the packing composed?

A. The packing is composed of a gland, ball joint, vibrating cup, three soft metal rings known as one ring, follower, preventer, spring, swab cup and oil cup.

Q. What is each part used for?

A. The gland No. 7 is used only to hold the packing in the stuffing box, and furnish a bearing or seat for the ball ring; the ball ring No. 4 is used to provide a universal joint between the vibrating cup No. 6 and the gland. This feature provides a floating packing that will follow the rod whether same is in line or not, always adjusting itself and maintaining a steam-tight joint at all times; the vibrating cup No. 6 is used for holding the packing rings in their proper positions; the packing ring No. 2 is of soft metal, and is the only wearing part of the packing, as it is the only part of the packing that comes in contact with the rod; the flange follower No. 3 is used to transmit the spring pressure to the packing rings, and to follow up the packing as wear takes place. The spring is used only to keep packing rings and all joints in position when steam is shut off, and not, as is generally supposed, to set packing rings in as wear takes place. The steam pressure, when the engine is working, takes care of this feature altogether. Were it not for the spring, however, when steam is shut off and engine drifting, there would be nothing to prevent packing from becoming disarranged in stuffing box. The preventor No. 8 is for the purpose of only allowing the packing to move backward and forward about 1-16 of an inch on the rod. Were it not for this preventor, when packing becomes a little dry or rod rough, packing would hang to rod on its inward stroke, compressing the spring until the coils become tight together, and when engine took steam, the



Parts referred to by number are as follows:

2—Three babbitt rings in halves, known as one ring; 3—flange follower; 4—ball joint; 5—swab cup; 6—vibrating cup; 7—gland; 8—preventer.

packing would be shot up against gland with sufficient force to smash the packing or break the gland. This preventor also performs another duty: that of furnishing a close fitting casing around outside of spring, and never allowing the spring to come in contact with the rod, by becoming cocked. The swab cup No. 5 is a very important part of the packing, as the oil cups do not satisfactorily accomplish the purpose intended, owing to losing covers, and cups filling with cinders, etc., oil pipes becoming choked up or broken off; therefore, the swab cup No. 5 should receive personal attention from engineman, as the packing will not run successfully, no matter how carefully applied, unless it gets some lubrication.

Q. . What is the principle of U. S. metallic packing?

A. That the soft metal rings, after ends come together, are forced by spring and steam pressure into vibrating cup, and against the rod or stem by the flow of the metal itself. The soft metal packing rings which come in contact with the rod, which do the actual work of packing, are cut with a small open space left between the halves, 1-16 of an inch being cut out when first applied, so that they may rapidly conform to the surface of the rod. When they have done this, the open space will be closed up and ends of rings come solidly together, and in this conditions rings are intended to wear, and will last four or five times longer than they would if continually cut so as to stand apart at ends. Do not cut the rings open at ends after once applied, as the wear on the rods will be excessive and the rings themselves will have an extreme tendency to force out between the vibrating cup and rod. If rings do not work properly when thus applied, and packing blows, there is something wrong with either the mixture of metal in the rings, their manufacture, or else the rod is tapered or badly shouldered. Piston rods and valve stems should be round and true. This is one of the first points necessary to efficient, satisfactory service. Rods and stems will wear, but in no case should they be allowed to become reduced over 1-32 of an inch without being turned up again. This saves much waste of steam and packing. Lubrication should be carefully looked after, as it largely affects the working of packing. A little oil properly applied, with oil cups and swab clean, will insure increased mileage for packing rings. See that swab is in good condition, and well saturated with oil. If swab is applied dry, as is the usual custom, any oil the cup might feed is soaked up by dry swab, and before swab becomes sufficiently saturated with oil to lubricate the packing, it fails for want of oil.

Q. How should packing rings be finished?

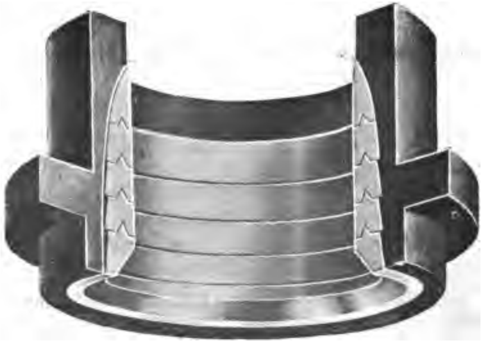
A. The only proper way to finish packing rings is to machine them all over, as it is impossible to mould packing rings to size, on account of shrinkage in the metal, the shrinkage varying according to mixture. Face individually the three rings; then assemble them on the mandrel, and turn the outside to conform to the vibrating cup; then remove from mandrel, and saw apart with 1-16-inch saw.

Q. How should packing be applied?

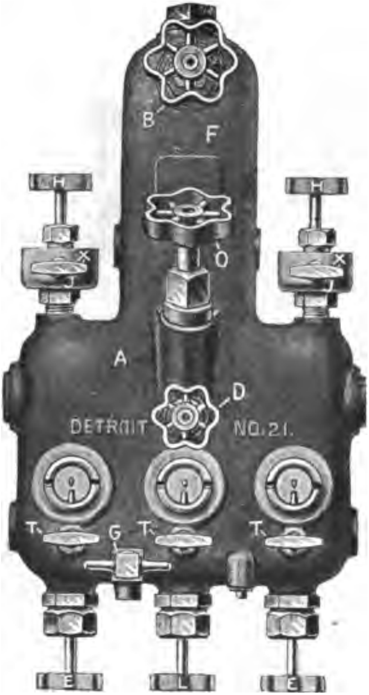
A. Do not apply one part of a packing ring when it is necessary to remove a set of packing for any cause. Always apply a complete new ring, and never, under any circumstances, use one part of a new ring and a part of the rings removed, as this does not allow the old rings to come up to their original bearing in vibrating cup. See that the rings fit vibrating cup on the conical surface without any lost motion or play. They should be the exact size of rod or stem to which they are applied. Do not apply new rings for all packing troubles. Investigation may show that something else is wrong. In applying new rings, or investigating trouble with packing, see that joints of rings are broken, examine faces of ball joint and vibrating cup, and see that they are clean and well oiled. Often, packing leaks are due to foreign matter between ground faces of gland, ball joint or vibrating cup. See that there are no leaks in gland joints, and that ball joints and vibrating cups are ground in a little when removed for making any repairs to cylinder or steam chest. See that vibrating cups are not more than 1-64 of an inch larger than rod or stem, when applied, and that they are removed when 5-64 larger. In investigating trouble with valve stem packing, be sure to see that valve stem is approximately central in the stuffing box. If not so, replace valve stem support bushing to bring it central. If this is not done, and vibrating cup comes in contact with gland, it will drag the rings out, causing them to wear rapidly.

NORTHERN METALLIC PACKING.

To apply, open the rings, and place them on the rod outside of vibrating cup, and push them into the vibrating cup together. Care should be taken to break joints well before placing in vibrating cup.



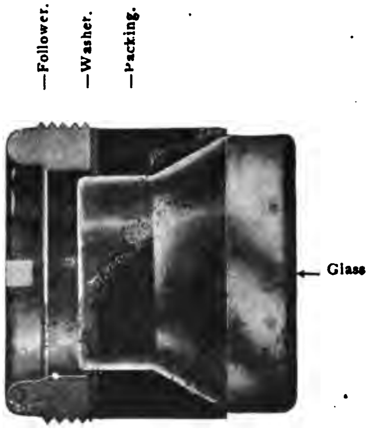
LUBRICATORS.



DETROIT NO. 21.

NAMES OF PARTS.

F—condenser; A—oil reservoir; O—filler plug; G—drain valve; TTT—sight feed drain stems; D—water feed valve; B—steam valve; EE—feed regulating valves; L—feed regulating valve to air pump.



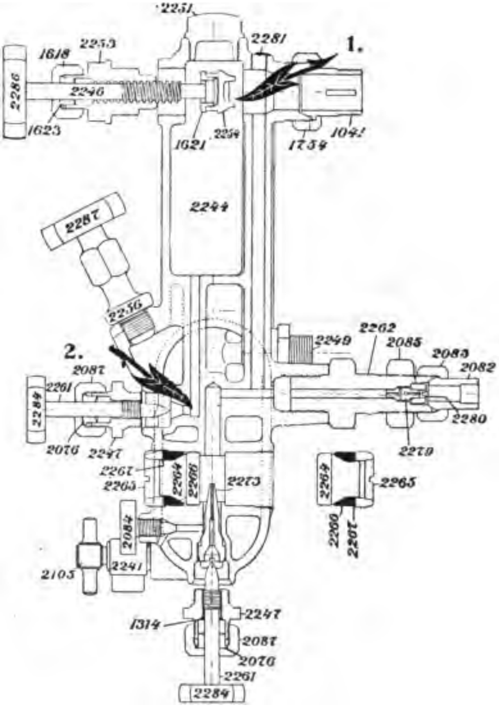
FULL SIZE.

TO OPERATE.

To fill, remove filler plug O, and fill the reservoir with clean strained oil. If there is not sufficient oil to do so, always use water to make up the required quantity. This will enable the feeds to start promptly.

Steam valve—the regular boiler valve should be left wide open, and the steam valve B, at top of condenser, must also be kept wide open while the engine is in service.

To start lubricator—1st. Be sure that the regular boiler is open; then open steam valve B at top of condenser, gradually, until wide open, and keep wide open while lubricator is in operation. Allow sufficient time for condenser and sight-feed glasses to fill with water. 2nd. Open water valve D.

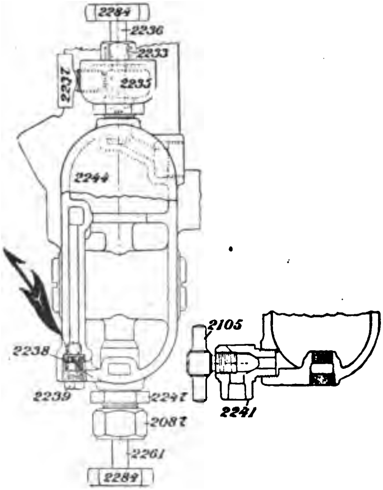


SIDE VIEW

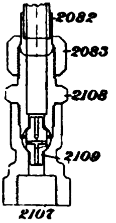
3rd. Regulate flow of oil to right and left cylinders by valves EE, and to air pump by valve L.

To operate auxiliary oiler.—See that valve H is closed; then open valve X, and fill body of oiler; close X after filling, and open H. To refill, always close valves EE and L in advance of valve D; open drain plug G, then filler plug O.

Immediately after filling the lubricator, do not fail to open water valve D, in order to prevent any excessive pressure due to the expansion of the heated oil. Blow out lubricator once a week.



SIDE VIEW

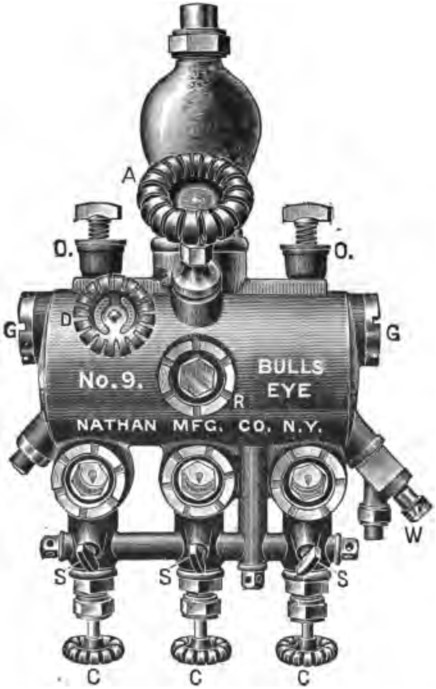


AUTOMATIC STEAM CHEST PLUG

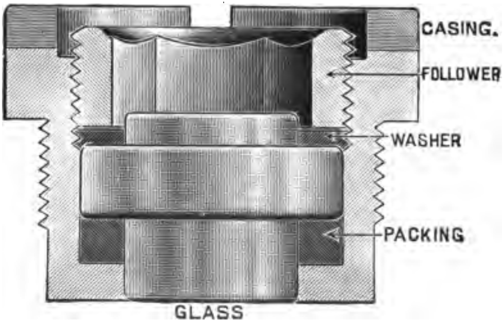
THE BULLSEYE LUBRICATOR.

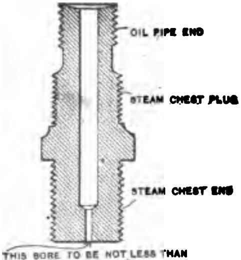
TO OPERATE.

Fill the reservoir through the filling plug A, and, immediately after filling, open water valve D. Open steam valve (not shown); wait until sight-feed chambers are filled with water; then start, and regulate feed by opening regulating valve C. To refill, close all valves marked C, and valve D; draw off water at waste cock W; open water valve D immediately

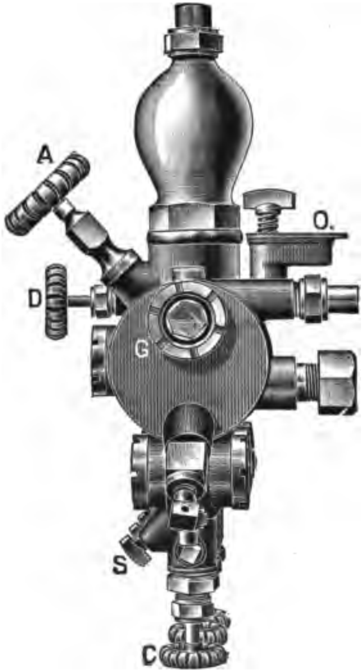


after filling, whether the feed is started again or not. To oil by hand, close the steam valve; fill the hand oilers O; open the hand oiler valves; and, when all the oil has entered the tallow pipes, close hand oiler valves, and open steam valve. Once in two weeks, at least, blow out the reservoir with steam, opening all valves wide, with the exception of the filling plug, which should remain closed.





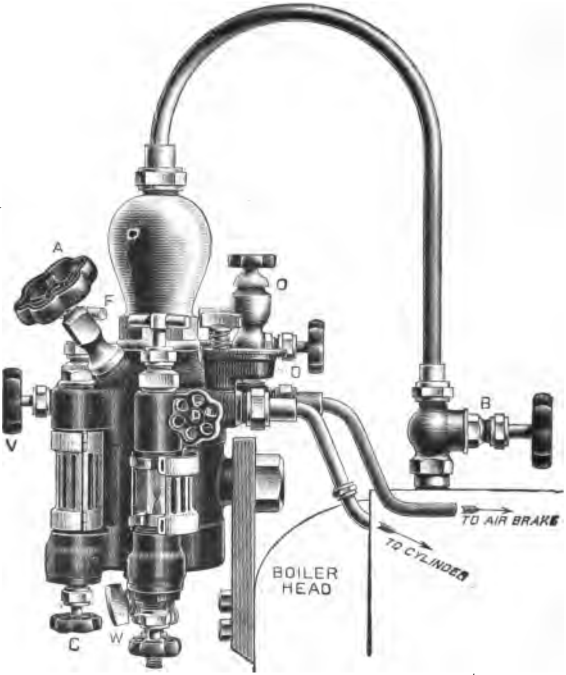
THIS BORE TO BE NOT LESS THAN $3/32''$ OR MORE THAN $1/8''$ DIAMETER



NAMES OF PARTS.

A—filling plug; D—water valve; OO—hand oilers; SSS—sight-feed drain valves; CCC—regulating valves; **GG—gauge** glasses; R—reserve glass; W—waste cock.

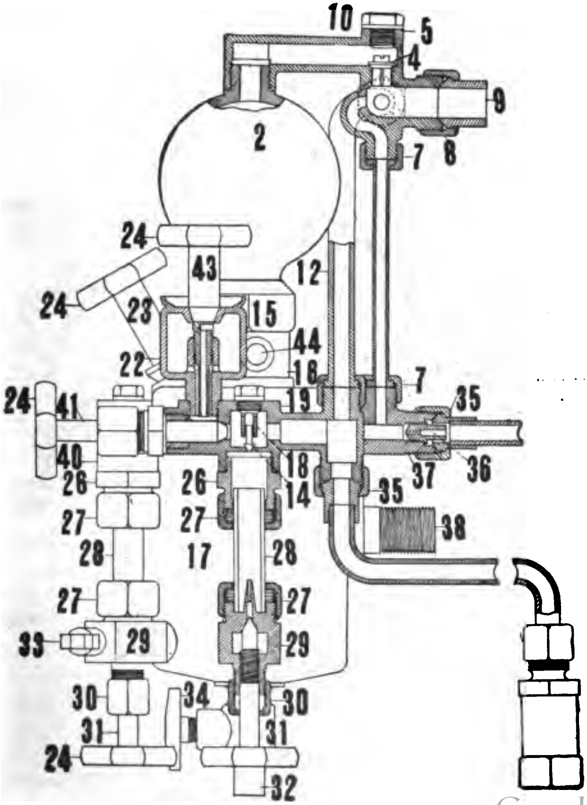
THE NEW NATHAN LUBRICATOR.



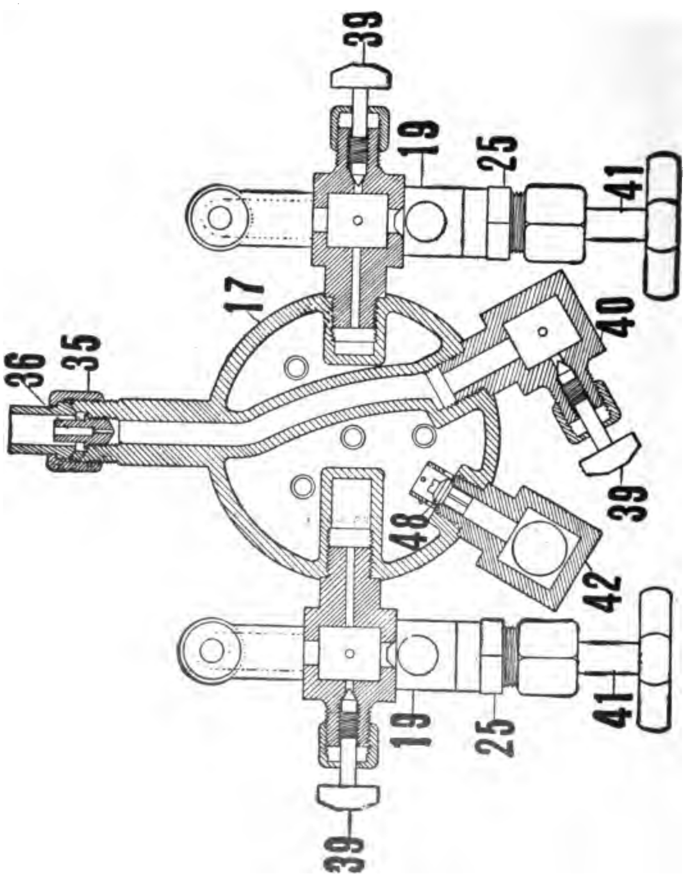
NAMES OF PARTS.

A—filling plug; B—steam valve; CCC—regulating valve; D—water valve; E—condenser; FFF—safety valves; OOO—auxiliary oilers; W—waste cock.

Valves FFF must always be kept open, except when one of the glasses breaks. In such case, close valves C and F, belonging to the broken glass, and use the auxiliary oiler O on that glass, on down grades, as a common cab oiler. The breaking of one glass does not interfere with the proper functions of the others. Always open the steam valve before the engine begins to do any work whatever. Keep water valve D always open, except during the period of filling. Blow out lubricator once in two weeks.



THE CHICAGO LUBRICATOR



NAMES OF PARTS.

2—Condenser; 9—steam inlet from boiler; 11—air pump circulating pipe; 12—steam chest circulating pipes; 19—upper feed arm right and left; 22—auxiliary oil cup; 26—sight-glass sleeve; 27—sight-glass packing nut; 28—sight-feed glass, ¾ x 3 inches; 29—lower feed arms; 31—feed valves; 33 drain valve lower feed arms; 36—choke plug for air pump feed; 39—pressure regulating valve; 40—air pump feed upper arm; 41—auxiliary oil cup feed valve; 42—index glass top arm; 43—filler plug for auxiliary oil cup; 44—water valve.

TO OPERATE.

1. To start the lubricator to feed: first, open steam supply valve at boiler (this admits steam into the connection at No. 9); next, open pressure valve 39 ⅛ turn on all upper feed arms; note glasses 28 to see if they are filled with water; if glasses 28 are filled with water, open water valve 44, and regulate feed with valve 31.

2. Valve 41 and plug 43, of auxiliary oil cup, must be kept closed when engine is supplied through feed glasses 28.

3. To use auxiliary cup 22: Close valve 41; open plug 43; fill cup; close 43, and open 41 one turn to allow oil to feed out.

4. To drain galsses 28: Close valve 39, and open 33.

5. To blow glasses 28 out with steam, after they have been drained, break joint on 39, and open 33.

6. To put condensed steam into glasses 28, after they are drained, close 33, and open 39.

7. If lubricator should stop or feed irregularly, open 39 wide to permit feed to regain its regularity, then set to ⅛ turn.

8. If glasses 28 should fill with oil when engine is running, reduce feed with 31, and open 39 wide. After glasses are clear, reduce 39, and regulate feed with 31.

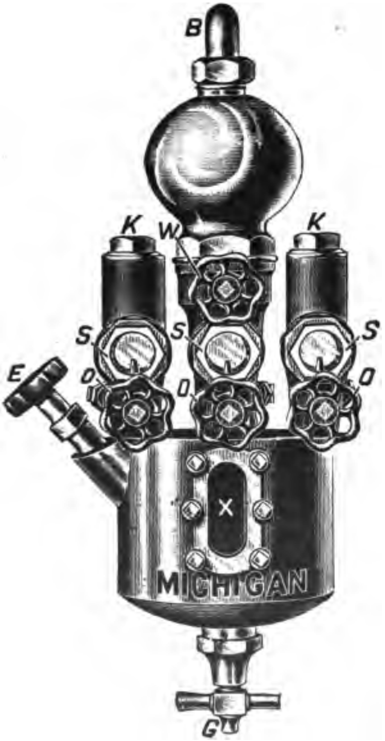
9. To renew glasses, loosen packing nuts 27; then detach glass sleeve 26, after which place new gaskets in the packing nuts. Put them on the glass with sleeve 26 on top. Put those in place, and screw down bottom nut first, to hold glass in position; then screw sleeve 26 up tight, and set packing nuts to hold the pressure.

MICHIGAN LUBRICATOR.

This lubricator has visible auxiliary oilers. Should a feed stem become temporarily disarranged or stopped up, open auxiliary oiler valve and oil will flow through the sight feed glass by a separate and direct opening from the body of the lubricator in any desired quantity; or should an engineer desire to flush the engine valves at starting, it can be done by the visible auxiliary oiler without disturbing the sight feed drop or changing the feed valves. After finishing a run, it is desirable to leave a slight steam pressure turned on the condenser by leaving the boiler valve very slightly open; by so doing the sight feed glasses will be kept clean and always full of clear water and ready for use.

Q. What will cause a lubricator to feed irregularly?

A. The irregularity in feed of lubricators is usually due to an enlarged opening in the choke plugs. The size of choke openings should not exceed 3-64 of an inch, except Nathan 1899 lubricator. The size of openings in feed nozzles should not exceed 3-32 of an inch. If the feed of the lubricator increases when the throttle of engine is closed, the lubricator should be considered out of repair.



Front View

Q. If the openings of the choke plugs become stopped up, how can they be opened?

A. Close the steam valve of lubricator and open throttle valve of engine. The pressure passing up through the oil pipes will usually force the substance in the plug down into feed glass.

Q. If the feed nozzles become stopped up, how can they be opened?

A. Close the water valve, and open the drain valve; the pressure will then force everything up into lubricator.

Q. What will cause a lubricator to syphon; that is, for the oil to mysteriously disappear from the oil reservoir when the feed valves are closed, and the water and steam valves open?

A. This is usually caused by defective casting, or water pipes being split or leaking where it screws into water passage in the casting. With the Detroit improved lubricator the trouble is usually at water check 2238. Cause: Scale or boring prevent ball check from seating.

Q. What will caues a variation of size of drop during a trip?

A. In alkali, salt water or oil well regions, through which railroads pass, the water supply becomes impregnated with saline matter. This saline matter is carried over in the lubricator mechanically by the steam, so that the water in sight-feed glasses contains considerable of it, and the amount increases as the locomotive proceeds on the trip, until it crystalizes around the feed cones, thus gradually diminishing the size of the opening for the drop. Should the engineer undertake to force the feed it will result in the oil flowing in a very slender stream,—scarcely perceptible. If this condition is not corrected, the salt crystals will completely close the feed-cone orifice.

How to rectify.—With lubricators having sight-feed drains, close all feed stems; open all sight-feed drains stems, and blow out thoroughly. The action of the steam on the feed cones will dissolve the salt crystals. With lubricators not having sight-feed drains, take out the feed cones, and clean them out. Allow reasonable time for condensation, start the feeds, and the drops will be normal. Never pound a lubricator. Such action on the part of the engineer indicates unfamiliarity with the principles, construction and care of a lubricator.

Q. What is "air bound"?

A. This condition is almost invariably brought about whenever it becomes necessary to fill the lubricator on the road. The temperature of a lubricator at such times is very nearly that of the steam pressure temperature. Sometimes the water-feed valve may leak, and, in order to fill the lubricator in this heated condition, it is found necessary to shut off all steam pressure to the lubricator, including the air pump; and; owing to the high temperature of the condenser, the water flashes into steam, practically emptying the condenser and feed glasses of all water. The oil reservoir being very hot, the oil expands rapidly, and the filler plug is usually put in before the reservoir is full, the steam and water pressure hurriedly turned on, and the feeds are opened before a reasonable time has elapsed for sufficient condensation to accumulate. The feeds will not respond under such conditions because the positive and negative pressures have equalized, and the lubricator is said to be air bound. To overcome, with lubricators having sight-feed drains, open all feeds and any one sight-feed drain stem. This will allow the water in the oil tubes and the air occupying the highest space in the oil reservoir to escape to atmosphere. The oil will quickly follow. Then shut this feed and vent stem until the condensation again fills the sight-feed chamber.

LUBRICATION.

Q. How should the cellars of driving or engine truck be packed?

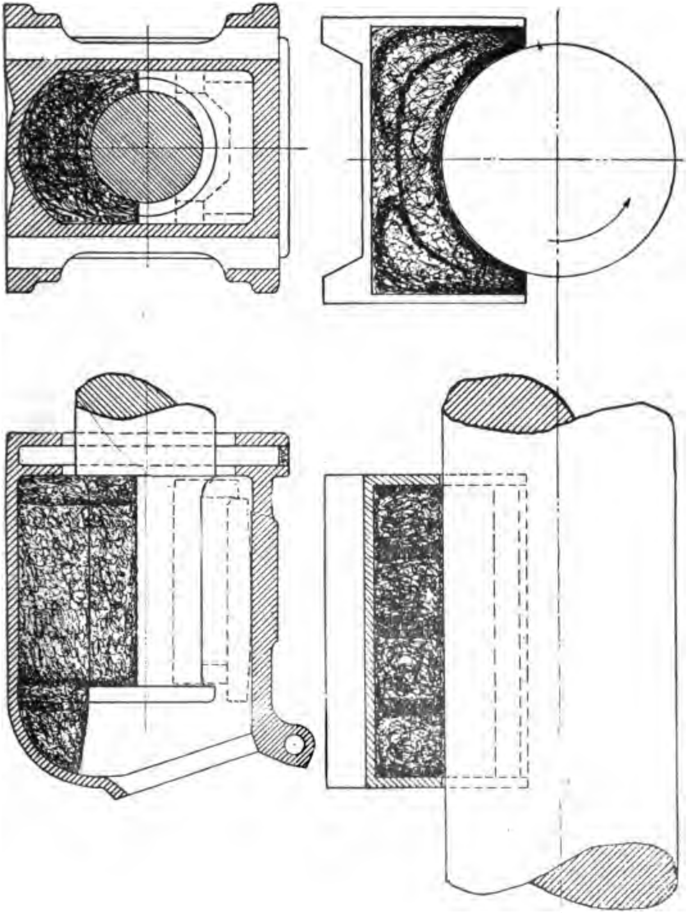
A. The packing should be placed crosswise of cellar, in four distinctly formed sections, with the ends of same rolled under, to reduce the tendency to be drawn up between the axle and brass. The packing should be placed in cellar moderately tight, to avoid settling away from the axle, which will occur in a short time, by the jarring of the engine, if not packed sufficiently close.

Q. How should journal boxes, under tenders of locomotives and cars, be packed?

A. The packing placed in journal box first should be in form of a roll, pressed out moderately dry, and packed tightly around back end of box for the purpose of not only retaining the oil but also to better exclude the dust. Then pack the box with loosely formed portions of packing, sufficiently firm under the journal to avoid settling away, which is caused by shocks when tender and cars are in motion. Pack it more lightly on each side of the journal, to avoid the wiping effect produced when waste is pressed too tightly between journal and side of box. Height of packing should not extend above center line of journal, and not beyond inside of collar. The packing placed between end of journal and front end of box, being the last put in the box, should have no thread connection with packing under or at side of journal, and should not extend more than ½ inch above lower edge of collar.

Q .How should the top of driving and truck boxes of engines be packed?

A. With a good quality of cotton waste, well saturated with oil. This packing should not be disturbed except when



absolutely necessary; and in case of removal from top of boxes it is essential to raise box off of journal, and wash out the oil cavities with water, under pressure, to thoroughly clear them of any accumulation of dirt, which usually results when the packing on top of box is removed.

Q. How often should the packing in cellars be examined?

A. Once every two weeks for through passenger engines, and once each month for local passenger and time freight engines, the packing in cellars should be carefully examined, and, if not found in proper contact with journal, freshly saturated packing should be added; this to be done only when packing is found in good condition on surface next to journal. All engines in general freight service should receive attention when there is any indication of journals being above running temperature.

Q. How long should tender boxes run with one oiling, if properly packed?

A. Passenger tenders should run at least one thousand miles, and freight, thirty days.

Q. How many drops per minute, of valve oil, should each cylinder have?

A. From 3 to 5 drops per minute, depending on the service. One drop per minute is enough for steam cylinder of air pump. Air cylinder should have a small amount of valve oil, each day or trip, put in through air cylinder oil cup—not the air inlets.

Q. When should a lubricator be started to feed?

A. Fifteen minutes before the engine starts to work.

Q. When preparing an engine for a trip, what should be done?

A. Before starting, the cylinder cocks should be opened long enough to drain out water. When starting, do not give the engine full throttle, as this practice forces all the condensed steam into steam chests and cylinders at one time, straining the joints, and causing them to leak, which results in imperfect lubrication and a waste of oil.

HOT BEARINGS

Q. What are some of the causes of bearings running hot?

A. Lack of lubrication; sand or dirt. Driving journals and tender and car journals often heat on account of the packing in the cellars and boxes settling away from the axles, caused by the jarring effect of the train while in motion. If an engine is low on one side, it may cause the back end of main-rod brass to run hot. Main-rod brasses sometimes run hot, caused by the holes in brasses at each end of the rod not being true with each other, and holding rod on a twist. Main rods being keyed too tight, eccentrics sometimes run hot, caused by straps being too tight, and sometimes it is caused by the valves not being properly lubricated.

Q. When a bearing is found to be hot, what should be done?

A. If a driving journal, tender or car journal, repacking is usually the best remedy. Graphite mixed with signal oil is a good cooling lubricant for hot bearings. If main pin gets hot, and starts to throw the babbitt out, do not stop until all the babbitt is out, for if the engine is stopped before the babbitt is all out, the oil passage is almost sure to be stopped up with it. For hot pins, slack the keys, and give them a good oiling; a little soap or graphite is very good to use with the oil. Water can be used to cool any hot bearing, if the bearing is not too hot, except a cast-iron eccentric strap. If the eccentric is hot, caused by the strap being too tight, slack the strap bolts a little. Graphite and signal oil mixed is very good for hot eccentrics. If a driving journal having spring saddle gets very hot, run that wheel upon a wedge, and block between the saddle and frame. This will take part of the weight off.

THE USE OF HARD GREASE IN DRIVING BOXES.

This system of lubricating driving boxes relieves the engineer entirely from the necessity of oiling the top of boxes. All oil holes in the top of driving boxes leading to journals are plugged, no oil being necessary, and, in fact, a detriment if mixed with the compound in lubricator.

It is only necessary to observe indicator pins projecting through bottom of cellar, which indicate quantity of compound in the lubricator. When the eye shown in letter K in the cut of pin is flush with the bottom of the cellar, there is sufficient compound for two or more weeks service, but the driving box should then be reported for repacking.

Temperature of journal or box will be much higher than with oil. There need be no alarm, however, if temperature should occasionally reach a point not to permit of holding the hand on end of axle. No injury whatever will occur to journal of box if indicator pins show a supply of compound in lubricator.

Under no circumstances should water be turned on driving box, although it may have reached what may be regarded as a high temperature. Water will develop serious difficulty by affecting the compound, causing it to quickly liquify and rapidly run out of lubricator, leaving it empty or dry. In any case of a driving box being considered very hot, the compound will take entire care of it until end of run much better than if it were possible to put oil, packing or water around the box. Boxes found at temperature described can be reported at end of run for examination. Hubs, shoes and wedges should be carefully oiled in the usual way.

THE FRANKLIN AUTOMATIC DRIVING BOX LUBRICATOR.

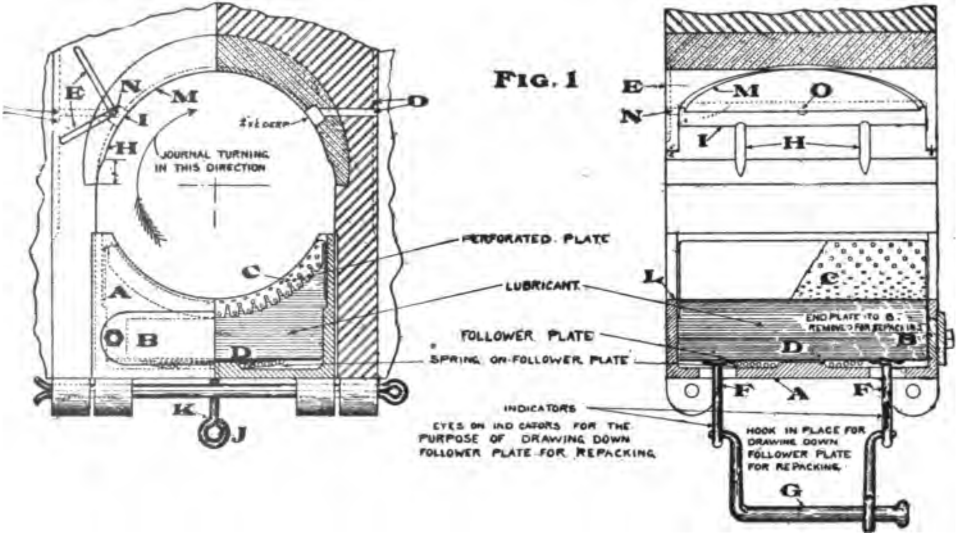


FIG. 1

E
N
M
I
H
O
DEEP
JOURNAL TURNING IN THIS DIRECTION
C
A
O
B
D
K
J
PERFORATED PLATE
LUBRICANT
FOLLOWER PLATE
SPRING ON FOLLOWER PLATE
INDICATORS
EYES ON INDICATORS FOR THE PURPOSE OF DRAWING DOWN FOLLOWER PLATE FOR REPACKING
E
M
O
N
I
H
L
C
END PLATE TO BE REMOVED FOR REPACKING
D
B
F
A
F
HOOK IN PLACE FOR DRAWING DOWN FOLLOWER PLATE FOR REPACKING
G

INJECTORS.

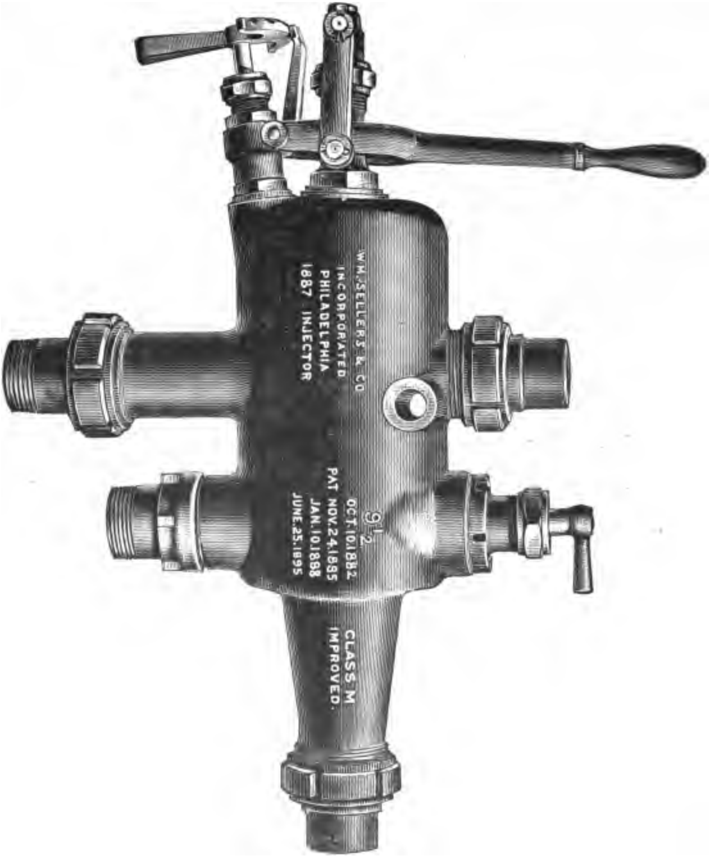
SELLERS INJECTORS.

LIST OF PARTS.

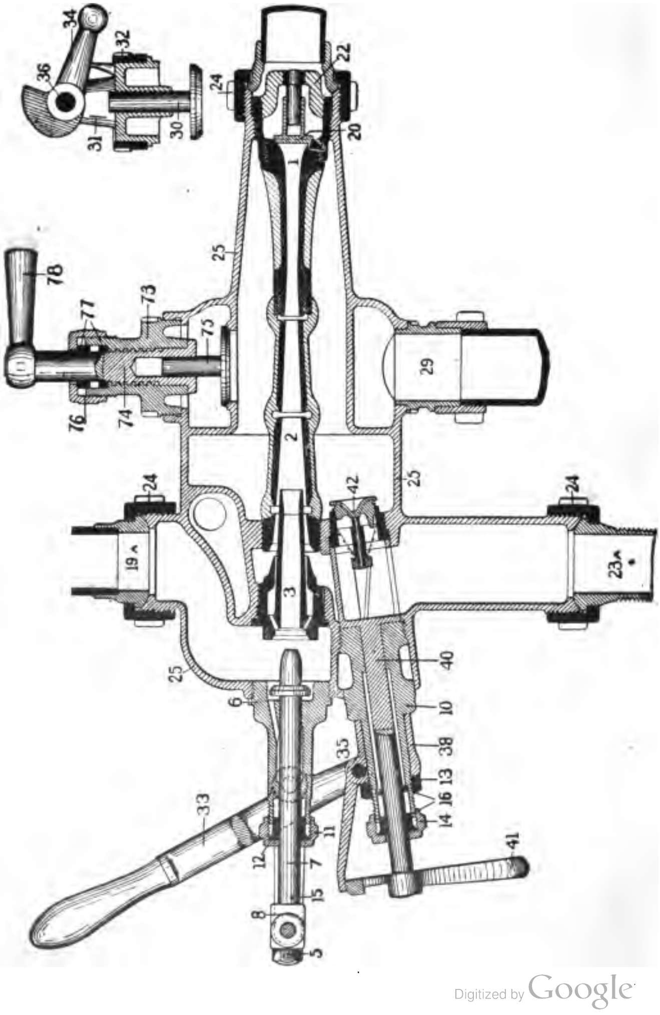
1—Delivery tube; 2—combining tube; 3—steam nozzle; 5—spindle nut; 6—steam stuffing box; 7—spindle; 8—cross-head; 10—water stuffing box; 11—follower; 12—packing ring; 13—lock nut; 14—follower for No. 10; 15—links; 16—packing ring; 17—water valve; 19—plain ring for copper pipe; 19-a—reducing ring for copper pipe; 20—check valve; 22—guide for No. 20; 23—plain union for iron pipes; 23-a—reducing union for iron pipes; 24—coupling nut; 25—injector body; 29—waste pipe; 30—waste valve; 31—guide for No. 30; 32—jam nut for No. 31; 33—starting lever; 34—cam lever; 35—pin Nos. 9 and 33; 36—pin through Nos. 31 and 34; 38—collar and index; 39—funnel; 40—plug water valve; 41—regulating valve; 42—inlet valve; 73—guide for overflow valve; 74—heater stem; 75—overflow valve; 76—follower on No. 73; 77—packing ring on No. 73; 78—heater stem.

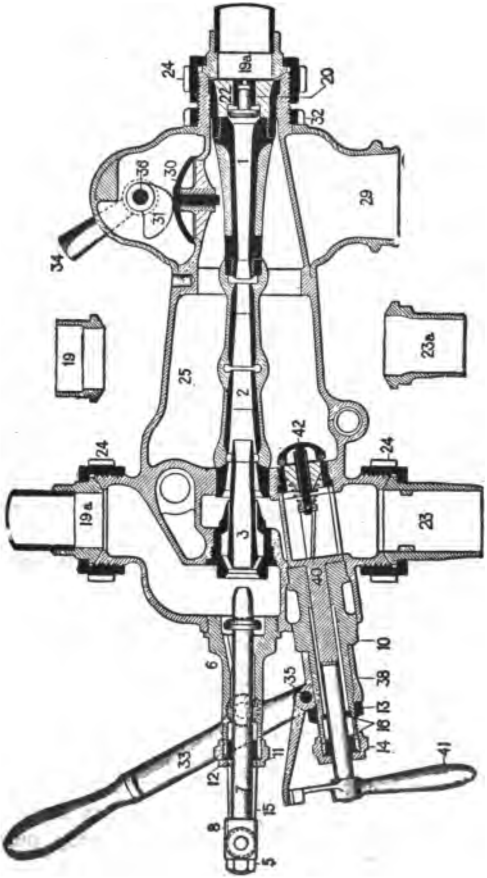
Method of operation.—To start, pull out lever; to stop, Regulate for quantity with water valve. To use as a heater, close waste valve, and pull starting lever out. In starting on high lifts, and lifting hot water, it is best to pull out the lever slowly.

Special features.—Automatic re-starting; self-adjusting without waste; increased delivery at high pressure; wide range of capacities; lifts and feeds hot water. Interchangeable with the Monitor and Ohio.



CLASS M IMPROVED—EXTERIOR VIEW.





CLASS N IMPROVED P. R. R. STANDARD.

SELLERS CLASS N IMPROVED P. R. R. STANDARD.

LIST OF PARTS.

1—Delivery tube; 2—combining tube; 3—steam nozzle; 5—spindle nut; 6—steam stuffing box; 7—spindle; 8—cross-head; 19—plain ring for copper pipe; 19-a—reducing ring for copper pipe; 20—check valve; 22—guide for No. 20; 23—plain union for iron pipes; 23-a—reducing union for iron pipes; 24—coupling nuts; 25—injector body; 29—waste pipe; 30—waste valve; 31—waste valve cam; 32—jam nut for No. 29; 33—starting lever; 34—cam lever; 35—pin Nos. 38 and 33; 36—cam shift; 37—washer on No. 36; 57—overflow pipe.

PARTS USED IN CONNECTION WITH WATER-REGULATING VALVE OF CLASS N.

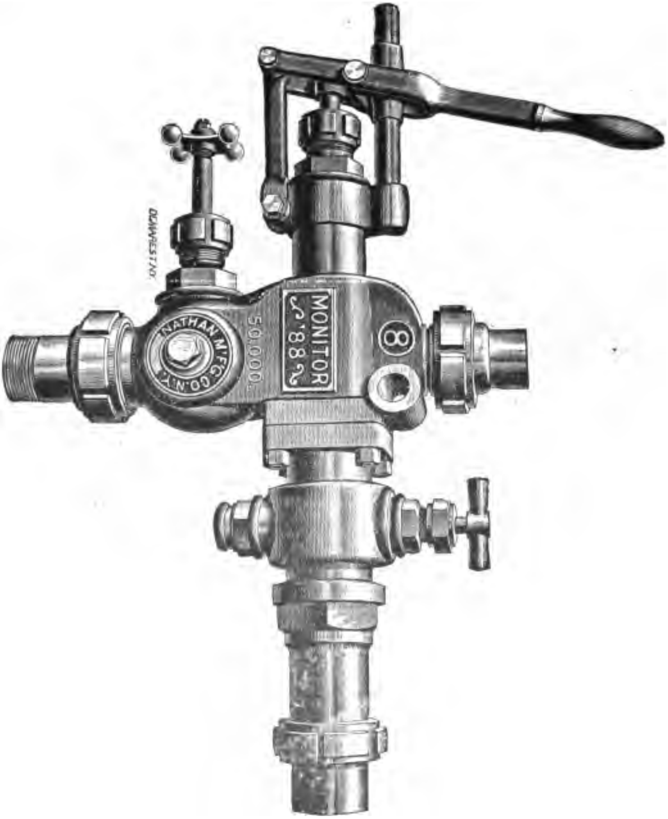
9—Collar on No. 10; 10—water stuffing box; 11—follower; 12—packing ring; 13—lock nut; 14—follower for No. 10; 15—link; 16—packing ring; 17—water valve; 18—ring in No. 17; 38—cam shaft; 40—plug water valve; 41—regulating handle; 42—inlet valve.

Class N has the same special features, and is operated the same as class M.

THE MONITOR INJECTOR, OF 1888.

TO OPERATE THE INJECTOR

With Lever Motion.—To start, pull out the lever a short distance to lift water; when water runs from overflow steadily, draw back the lever until overflow ceases. Do not increase the steam supply after overflow has ceased. Regulate for quantity with water valve W. To stop, push in the lever.



THE MONITOR INJECTOR.

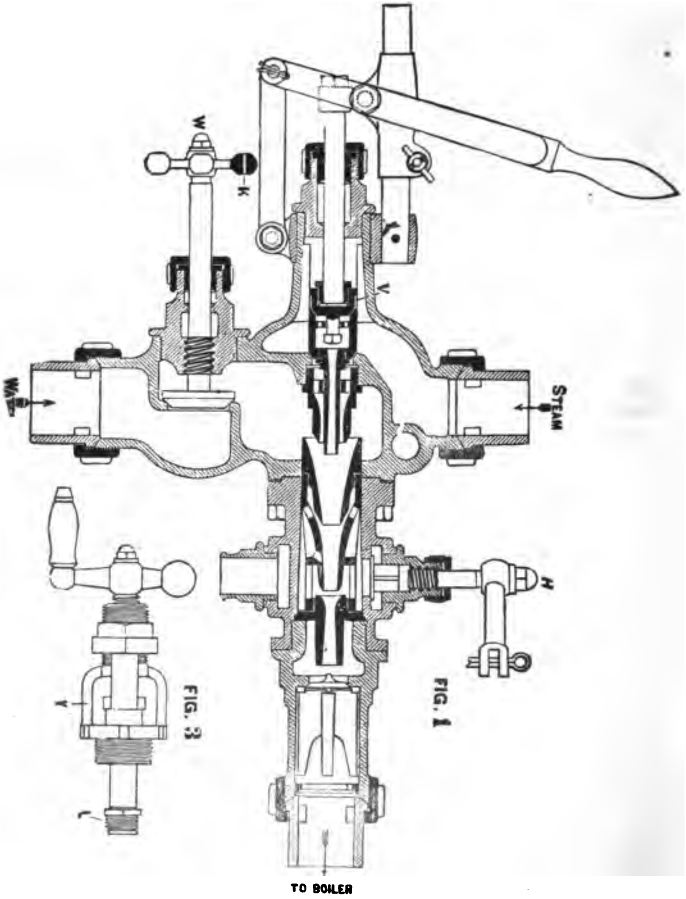


FIG. 1

FIG. 3

THE MONITOR INJECTOR—INTERIOR VIEW.

With Screw Motion.—To start, open steam valve one-quarter turn to lift water; when water runs from overflow, open steam valve until overflow ceases. Do not increase the steam supply after overflow has ceased. Regulate for quantity with water valve W. To stop, close steam valve.

TO GRADE INJECTOR.

Throttle water by valve W. If this is not sufficient, reduce the steam by pushing in lever handle about half way, and, in case of the screw motion, by screwing in the steam spindle about half way.

TO USE AS A HEATER.

Close valve 8 (overflow valve), and pull out lever all the way, and, in case of screw motion, open valve full. At all other times, valve 8 must be kept open.

WATER VALVE W.

The hole in top knob (K) of water valve (W) indicates the position of the water valve. One turn of the handle fully opens or entirely closes the water passage. In either case, the knob with hole in it should be in upright position. Intermediate position of the knob (K) indicates corresponding openings in the water passage.

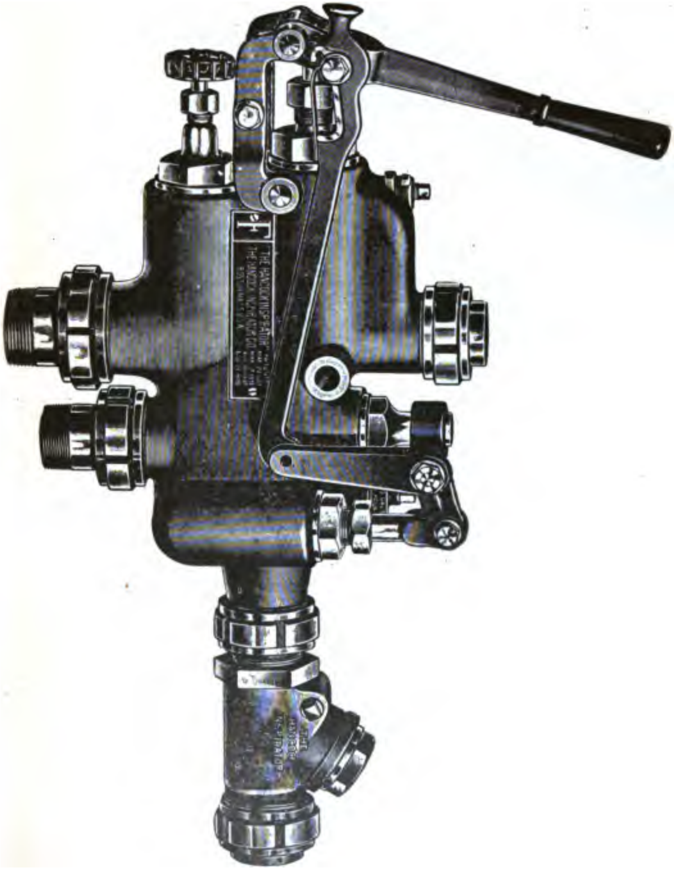
THE HANCOCK LOCOMOTIVE INSPIRATOR, TYPE F.

TO OPERATE.

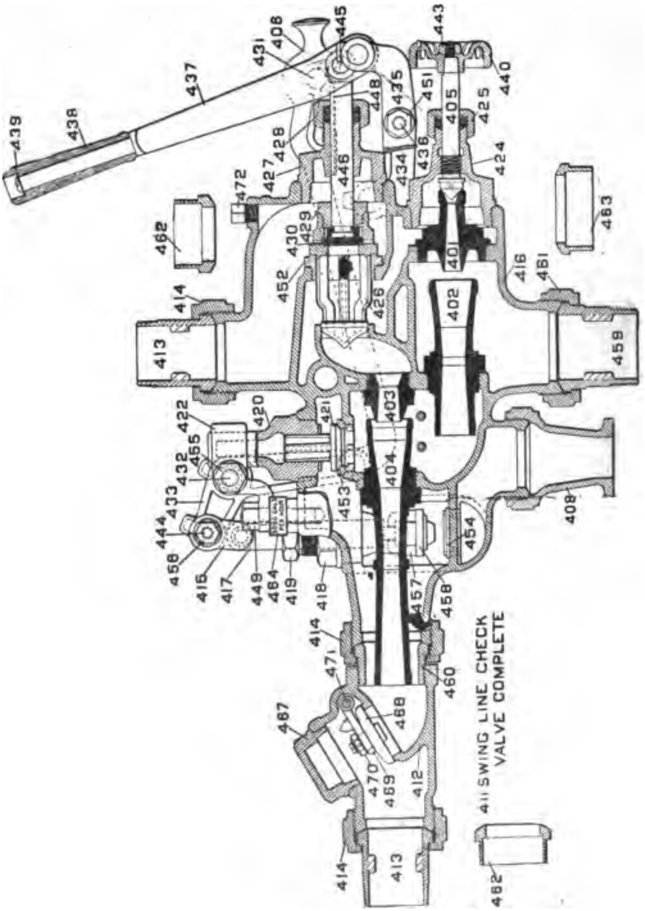
To start the inspirator, draw the lever (part No. 437) back to lift the water; then draw it back to the stop. When the lever (part No. 437) is drawn back slightly, steam is admitted to lifter steam valve (part No. 430), through forcer steam valve (part No. 426) to the lifter nozzle (part No. 401). The flow of steam into the lifter tube (part No. 402) creates a vacuum, and causes the water to flow through the lifter tube (part No. 402), condensing the steam, and out through the intermediate overflow valve (part No. 421), and through the final overflow valve (part No. 417) in the delivery chamber. A further movement of the lever opens the forcer steam valve (part No. 426), admitting steam to the forcer steam nozzle (part No. 403) and to the forcer tube (part No. 404), creating a pressure in the delivery chamber sufficient to close the intermediate overflow valve (part No. 421), and open the swing line check valve (part No. 411). The final overflow valve (part No. 417) will be closed, and the inspirator in full operation when the lever is drawn back to stop.

TO REGULATE THE AMOUNT OF WATER.

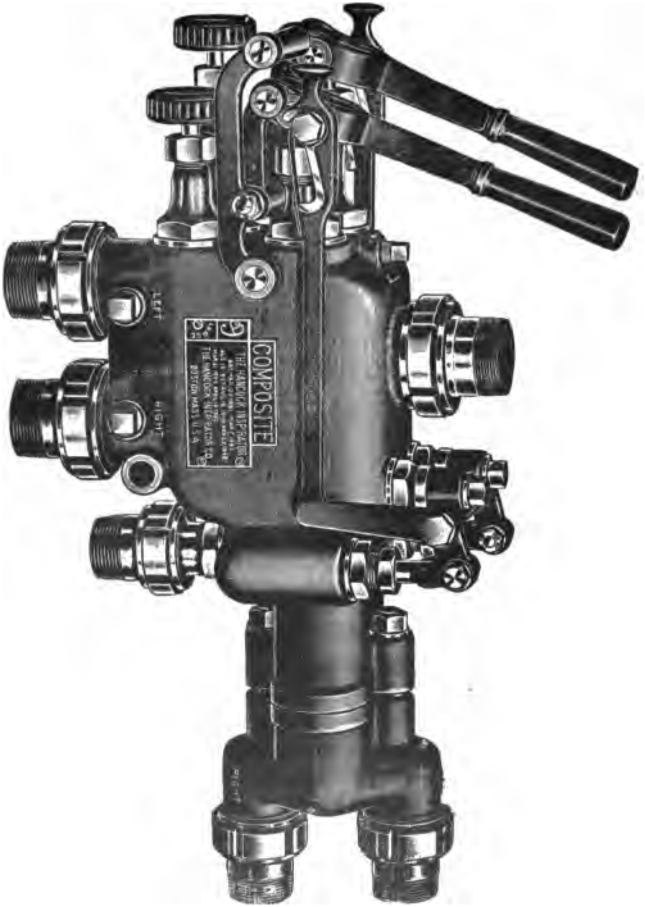
When the pin in the wheel of the regulating valve is at the top, the inspirator will deliver its maximum quantity of water. To reduce the feed, turn the regulating wheel to the right.



HANCOCK LOCOMOTIVE INSPIRATOR—TYPE F.



HANCOCK LOCOMOTIVE INSPIRATOR—TYPE F—INTERIOR VIEW.


LEFT
RIGHT
COMPOSITE
THE HANCOCK INSPIRATOR CO.
THE HANCOCK INSPIRATOR CO.
BOSTON MASS U.S.A.

HANCOCK INSPIRATOR—TYPE COMPOSITE.

TO USE THE PATENT HEATER ATTACHMENT.

Lift the connecting rod (part No. 406) until disengaged from the stud in the lever (part No. 431); then draw back the connecting rod to close the overflow valve (part No. 417); draw the lever back to the point used for lifting. This will usually give all the steam required for a heater. If the amount going back is too large, regulate it, by the regulating wheel, to just the desired amount, as, with the lever in the position described, all steam blowing back would pass through the lifter nozzle; therefore, the closing of main steam valve at the boiler becomes unnecessary.

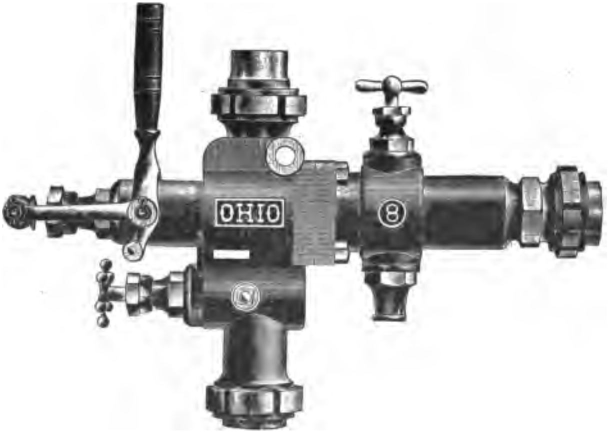
SPECIAL FEATURES.

The Hancock inspirator—type F—is a lifting inspirator, designed so that by change of nozzle and tubes the same machine is capable of delivering various maximum capacities of 2,500, 3,000, 3,500, 4,000, 4,500 or 5,000 gallons per hour. This makes it possible to use one standard size inspirator for the various sizes and types of locomotives in use. The inspirator, therefore, is universally interchangeable.

TYPE COMPOSITE.

The Hancock inspirator composite consists of two separate and individual inspirators, within one body or casing, which can be operated separately or simultaneously, as desired. Where it may be desired to locate both injectors on one side of the locomotive, convenient to the engineman, or on the end of boiler, the advantage of the composite are apparent. It places both instruments directly under control of the engineman, and both are equally convenient to operate, the result being that both instruments are operated and kept in good order. Each instrument has an independent suction pipe, delivery pipe and line check valve, thus enabling each to be operated independently of the other. To operate either instrument, draw the lever back until the water is lifted; then draw back as far as it will go. To put both instruments in operation, start one and then the other.

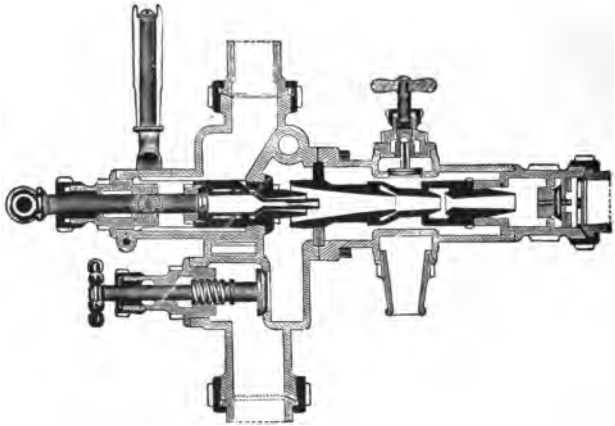
OHIO INJECTOR.



EXTERIOR VIEW.

TO OPERATE.

To start, pull lever back until the resistance of primer is felt. Soon as water appears at overflow, pull lever back as far as it will go. To regulate for quantity, use water valve.



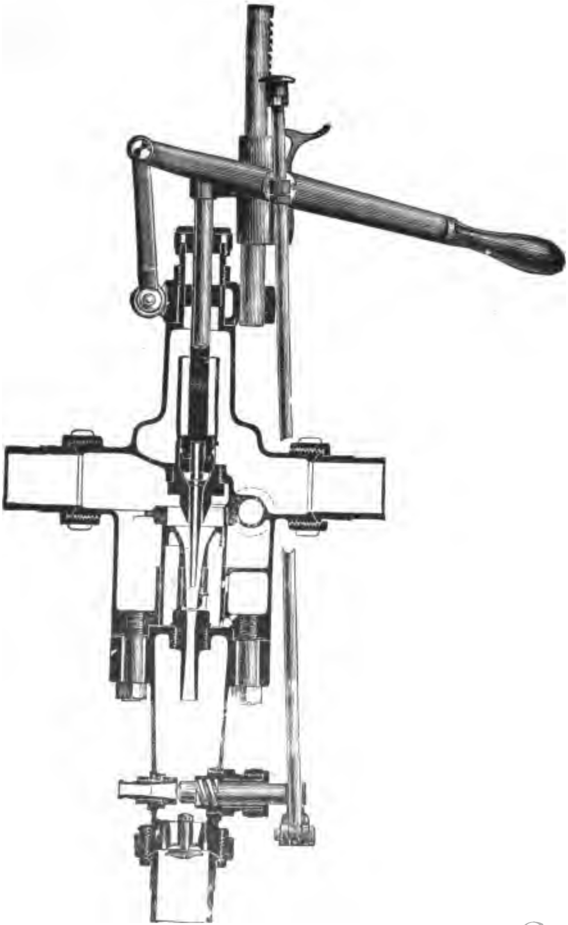
INTERIOR VIEW.

TO USE AS A HEATER.

Close the overflow valve, and pull the lever back until the resistance of the main valve. This lifts the water. When Overflow valve must not be closed except when injector is used as a heater or a test for leaks.

SELLERS OF 1876.

To work the injector, pull the lever out until you feel the resistance of the main valve. This lifts the water. When water runs from overflow steadily, draw back the lever all the way. To regulate the feed, push in the lever to the required notch. To use as a heater, pull lever out, and close overflow.



SELLERS OF 1876.

Q. What are some of the defects that will prevent injectors from lifting and priming when the injector is in fair working condition?

A. The injector should not be condemned if it fails to lift or force the water, as the injector is seldom the cause, and is often the index pointing to the cause of trouble. A leak in feed pipe anywhere between injector and tank, hose or fishervoir strainers stopped up, hose lining becoming loose, hot water in feed pipe, tank becoming air tight caused by freezing up, will prevent an injector lifting and priming. The overflow nozzle or overflow pipe becoming filled up, contracting the openings, will cause an injector to be slow in lifting and priming. To test for a leak in feed pipe, close tank valve and overflow valve, and pull lever back until resistance of primer is felt. This will admit steam into feed pipe. In this way a leak can be readily located. Sometimes an injector will not lift, caused by boiler and injector line checks leaking. If the boiler check is on the outside of boiler, it can usually be seated by tapping on the outside of the check valve case. If this can not be done, try opening the frost cock on the delivery pipe, and pouring cold water on feed pipe under injector. If injector will not lift, caused by the strainers in hose or fishervoir being clogged up, the dirt can usually be blown back into the tank by pulling the lever back and closing the overflow. The strainers should be taken out and cleaned out at the first chance. If the injector will not lift, caused by the hose lining becoming loose, take the hose off and turn it end for end. If the injector will not lift, caused by hot water in feed pipe, try pouring cold water on feed pipe under injector; if this fails, disconnect the hose, and allow the hot water to escape.

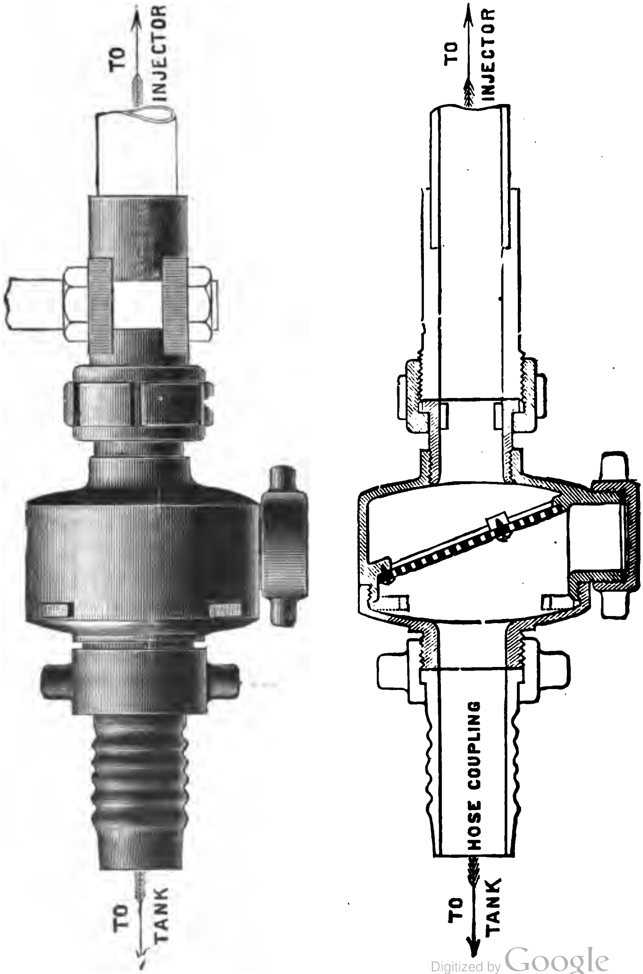
Q. What will prevent an injector from forcing water when the injector is in fair working condition?

A. Any obstruction in feed pipe, as a partly closed tank valve, strainer in hose or fishervoir partly closed with dirt, kink in hose, or hose lining loose—anything that will prevent the injector from lifting sufficient water to condense the steam coming through the forcer steam nozzle will cause the injector to break (fly off). A boiler check valve stuck shut will prevent an injector forcing water; a boiler check stuck partly closed will cause an injector to force part of the water into the boiler, and part out of the overflow, except in case of a closed overflow injector, in which case the injector will break (fly off). In case of a boiler check being stuck shut or partly closed, set the water-regulating valve at half capacity, and tap the boiler check valve case on top with hammer to loosen it in its guide. With the water-regulating valve set at half capacity the injector will give a higher back pressure than with water-regulating valve wide open. In most cases this will be effective. If the boiler check is stuck open, and can not be got back to its seat again by tapping and pouring water on check valve case, and the injector line check leaks bad or is held off its seat, there is nothing to prevent the water in the boiler going back into the tank. To prevent the water in the boiler going back into the tank, if the injector has a water-regulating valve that will close water-tight, close it, and close the overflow valve. If the injector has not a water-tight water-regulating valve, try reducing the steam pressure. Open the frost cock in delivery pipe, and see if the leak can not be reduced so that the hose can be disconnected, and a wooden plug driven into the feed pipe. Connect the hose up to keep the plug in. Use the other injector to run in with.

Q. Why should the feed pipe be kept absolutely tight?

A. Any leak of air reduces the capacity of the injector.

Q. Why should the delivery pipe and boiler check valve be of ample area?



THE NATHAN IMPROVED TANK STRAINERS.

A. If the delivery opening is too small, the power of the injector is wasted in increased friction in the pipes.

Q. What should be done before reporting a boiler check leaking?

A. Close the valve in the injector steam pipe from boiler. It is the custom of a great many engineers to report the boiler check as leaking if there is steam and water escaping from the injector overflow. This often is right, as there is very little attention given the injector line checks, and they nearly all leak. The injector steam valve will cause this, if it leaks, and, by closing the valve in the injector steam supply pipe from the boiler, it can be determined which is causing the trouble. This will save the shop men unnecessary work.

SETTING UP WEDGES AND KEYING UP.

Q. In what position should crank pin be on the side of the engine the wedges are being set up on?

A. On the top quarter. A block should be placed on the rail, back of the wheel, and the engine moved back against it, the object being to jam the driving box up solid against the shoe, so that whatever lost motion there may be will be at the back end of the box. The engine should have steam up when her wedges are set up, as the parts of the frame at the fire box expand, or become longer than when the engine is cold.

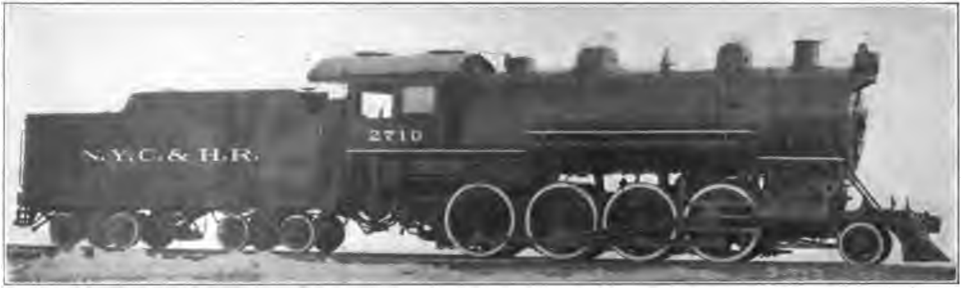
Q. In what position should the pins be to key up main rods?

A. Forward top eighth.

BROKEN SPRING OR SPRING HANGER.

What should be done in the event of a spring or a spring hanger breaking?

A. If a spring breaks on an eight-wheel engine, that is, the forward spring or hanger, place a fish-plate, or some other piece of iron, between the top of the back box and frame, on the side the broken spring or hanger is. Place a wedge on the rail, and run the back wheel up on it. This will take the weight off the forward box. Block solid with wood between the top of forward box and the frame; remove spring saddle if necessary; let engine down, remove the fish-plate from back box, and run main wheel up on the wedge, which will take the weight off the back box, and relieve the equalizer. Pry up the front end of equalizer, and block it solid. Let engine down, and remove all broken parts. If the back spring or hanger is broken, reverse this performance. If the front driving spring on a ten-wheel engine breaks, run the front driver up on a wedge. This will relieve the tension of the spring. Pry the front end of the front equalizer up, and block between that end of this equalizer and the lower part of the frame. Run the front driver off the wedge, and run the second driver up on it; block between the top of the front driving box and the frame. This will cause the front driver to carry a portion of the weight. If the main driving spring of a ten-wheel engine breaks, run the front and back drivers up on wedges, and block between the top of the main driving box and the frame. This will cause the main driver to carry a portion of the weight. Run the front and back drivers off the wedges, and run the main driver up on a wedge. This will relieve the spring rigging some. Pry up the back end of the front equalizer, and block between it and the lower frame rail; pry up the front end of the back equalizer, and block between it and the top frame rail. If back driver spring breaks, on a ten-wheel engine, run the back driver up on a wedge; pry up the back end of the equalizers, and block between that end and the top frame rail; run the back driver off the wedge, and the main driver up on a wedge, and block between the back driver box and the frame. This will cause the back driver to carry a portion of the weight. If the front spring breaks, on a consolidation engine, the cross equalizer will drop down on the bottom frame rail. Jack up the back end of the long truck equalizer, and block between the frame and the bottom of the cross equalizer; run the second wheel up on a wedge, to raise the frame to its proper height above the front box, and block between the top of the front driver box and the frame. If the second driver spring breaks, on consolidation, place a piece of iron between the top of the front driving box and the frame, and run this wheel up on a wedge, to raise the frame to its proper height over the second driver box; block between the second driver box and the frame, so the second driver will carry a portion of the weight; pry up the front end of the front equalizer, and block between this end and the frame; run the front driver off the wedge, and remove the block. If the forward spring breaks on a Mogul engine, it may be necessary to remove both forward springs, and block on top of both forward boxes. When both forward boxes are blocked, block intermediate equalizer to truck, also. When spring hangers straddle the frame, it is sometimes possible to block between the hanger and the frame. If the large spring below the frame and between the drivers breaks, block between both long hangers and the bottom of the frame. If the small coil spring hanger, back of the rear drivers, breaks, if it is possible to remove one of the small equalizers which rides the back box, block on top of box A chain can often



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be used in place of a broken spring hanger of the trailer wheel on an Atlantic or a Pacific type engine, or for some spring hangers on any type of engine. With engines having underhung spring riggings, the only difference is that one end of the equalizer has to be chained up to the frame, or the other end of the same equalizer blocked down from the frame.

BROKEN FLANGE, TIRE OR AXLE.

Q. What should be done in the event of flange on a pony wheel breaking?

A. If there is not too much of the flange broken off, the engine can be run to the shop, by running very carefully on curves, and over frogs and switch points. If there is more of the flange broken off than is considered safe to run in with, or if there is part of the tread of the wheel broken, chain or block the wheel so that it will slide with the good part of the wheel on the rail.

Q. What should be done in the event of the tire on a driving wheel breaking?

A. If a tire breaks and there is no other damage done, run the wheel with the broken tire up on a wedge about the thickness of the tire; remove the oil cellar, and block between the pedestal cap and the bottom of the driver box; then place a block of wood between this block and the driving axle; block between the top of frame and bottom of spring saddle; cut driver brake out. The rods will not have to be taken down if they are not damaged. If it is a back driver, and the second driver has a blind tire on, it will be necessary to chain around the tail piece of the engine frame on the disabled side, and pass the chain up and across to the opposite side, and secure it to the front corner of the tender frame. Wedge it there as tight as possible, so that it will crowd the flange of the rear driver against the rail. Run very carefully.

Q. What should be done in the event of a driver axle breaking?

A. This is a very serious accident, and may strip one side of the engine. Any axle breaking requires the removing of a part of the rods, and if a main axle, all rods will have to be taken down except one main rod. It is usually a time saver to ask for help, stating what is broken or damaged, so the shopmen will know what tools to bring with them, as there are no tools on the engine to do the work with.

SPEED TABLE No. 1.

SPEED, SECONDS PER MILE IN MILES PER HOUR.

Minutes Per mile	Seconds Per mile	Miles Per hour	Minutes Per mile	Seconds Per mile	Miles Per hour
5	00	12.00	1	20	45.00
4	00	15.00	1	18	46.15
3	00	20.00	1	16	47.37
2	50	21.18	1	15	48.00
2	40	22.50	1	14	48.65
2	30	24.00	1	13	49.31
2	24	25.00	1	12	50.00
2	20	25.72	1	11	50.70
2	15	26.67	1	10	51.43
2	10	27.69	1	9	52.17
2	5	28.80	1	8	52.94
2	00	30.00	1	7	53.73
1	55	31.30	1	6	54.55
1	50	32.73	1	5	55.38
1	45	34.29	1	4	56.25
1	42	35.29	1	3	57.14
1	40	36.00	1	2	58.06
1	38	36.73	1	1	59.02
1	36	37.50	1	0	60.00
1	34	38.29		59	61.02
1	32	39.13		58	62.07
1	30	40.00		57	63.14
1	28	40.91		56	64.29
1	26	41.86		55	65.45
1	24	42.86		54	66.66
1	22	43.90		53	67.92

SPEED TABLE NO. 2.

SPEED, SECONDS PER MILE IN MILES PER HOUR.

Seconds per mile	Miles per hour	Seconds per mile	Miles per hour	Seconds per mile	Miles per hour
24	150	47	76.6	70	51.4
25	144	48	75	71	50.7
26	138.5	49	73.4	72	50
27	133.3	50	72	73	49.3
28	128.5	51	70.5	74	48.6
29	124.1	52	69.2	75	48
30	120	53	67.9	76	47.3
31	116.1	54	66.6	77	46.7
32	112.5	55	65.4	78	46.1
33	109	56	64.3	79	45.5
34	105.8	57	63.1	80	45
35	102.8	58	62	81	44.4
36	100	59	61	82	43.9
37	97.3	60	60	83	43.3
38	94.7	61	59	84	42.8
39	92.3	62	58	85	42.3
40	90	63	57.1	86	41.8
41	87.8	64	56.2	87	41.3
42	85.7	65	55.3	88	40.9
43	83.7	66	54.5	89	40.4
44	81.8	67	53.7	90	40
45	80	68	52.9	91	39.5
46	78.2	69	52.1	92	39.1

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